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PROPHYLACTIC DIGITALIZATION BEFORE HIP ARTHROPLASTY IN SO CALLED ELDERLY AND MIDDLE-AGED PATIENTS

Introduction

The cardiovascular system of patients who undergo anesthesia and orthopedic hip surgery is a factor of multiple stress resulting from respiratory depression and myocardial contractility. The change of body temperature, arterial blood pressure, ventricular filling pressure, blood volume and activity of the autonomous nervous system, are factors contributing to the stress. Complications during the anesthesia and operation such as large blood loss, infection, lung embolism, myocardial infarction are the additional strain on the cardiovascular system. Even when cardiovascular diseases had been compensated before surgery, the patient's organism may be unable to sustain increased perioperative complications without heart arrest, myocardial ischemia or both. [1-6].

Besides already known direct or indirect effects of anesthetic agents on the heart, mediating primarily through the autonomous nervous system, the additional factors such as uncontrolled ventilation or inadequately controlled hypoxia, acidosis, hypercarbia, may further depress the myocardial contractility and decrease the arrhythmia threshold. The combination of mentioned variables may lead to changes in the arterial and central venous pressure, minute volume, heart frequency and rhythm.

A high frequency of perioperative life-threatening cardiac complications and mortality of middle-aged and elderly patients undergoing total hip endoprosthesis has been established by a retrograde analysis of an electrocardiogram and on X-ray film of the heart and lungs. Therefore, we have undertaken a prospective study to establish the effect of preoperative treatment with digoxin in patients in whom this treatment was necessary. The main aim of this research was to estimate the dimension of surgical risk and preoperative prophylactic treatment with digitalis glycosides.

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Patients and methods

One hundred and forty-one patients with anticipated latent systolic heart dysfunction who underwent hip arthroplasty at the Orthopedic Clinic, School of Medicine, University of Zagreb, have been included into the analysis of preoperative preparations and perioperative complications. The patients varied in age from 40 to 90 years (mean age, 63 years). They were divided into three groups based on preoperative basic cardiac analysis, electrocardiogram examination and the determination of heart volume from a chest roentgenogram. The research results of preoperative and postoperative parameters were compared with data of 120 patients in the average age of 67 years (40-89) from the control group, which earlier underwent the same operation, but were neither preoperative prepared nor selected according to the cardiovascular status. Their data were taken from medical records.

Electrocardiogram was made in all patients before and 24 hours after operation. Following parameters were analyzed: heart frequency, arrhythmias and conduction disturbances. The following ECG signs of ischemic cardiac disease and digitalis saturation were selected: a) S-T segment, b) corrected Q-T interval calculated by the formula of BAZETT [7], i.e. according to the nomogram of KISSIN et al. [8, 9], derived from this formula. The corrected Q-T interval is considered to reflect the digitalis effect if it measures 0.37 seconds or less [9]. The measured Q-T interval in seconds was corrected for heart frequency by means of the following expression:

$$\text{corrected Q-T interval (s)} = \frac{\text{corrected Q-T interval (s)}}{\text{R-R interval (s)}}$$

The upper limit of corrected normal Q-T interval values for woman measures 0.432 seconds and for men 0.422 seconds. In all patients the serum potassium level was analyzed.

The calculation of heart volume, (anterior and left lateral views) expressed in millilitres per square meter of the body surface area was done by a formula derived by JEFFERSON [10].

$$V = \frac{L \times B \times D \times 0.43}{A}$$

in which L is the long diameter from the superior vena cava and right atrial junction to the cardiac apex; B, the broad diameter from the diaphragm/right atrial junction to the pulmonary trunk/left atrial appendix junction; D, the depth diameter representing the greatest horizontal depth of the heart; and $0.43 \times M \times K$, in which M is the magnification factor (Q68); K, the ellipsoid constant (0.63); and A is the body surface area in square meters derived from the height and weight tables.

In 49/141 patients because of painful hip mobility, arm ergometer test with maximal load was performed using an apparatus of the firm "MONARK".

Estimation of the patients was done according to the functional classification of the New York Heart Association (NYHA) [11]: class I: dyspnea under greater load, under usual circumstances without discomfort, class II: smaller activity limitations - dyspnea under usual load, class III: significant body activity reduction - dyspnea under smaller load, no discomfort at rest, class IV: dyspnea at rest - heart failure.

The decrease of functional aerobic capacity more than 25% [16] directs attention to the fact that examinees are cardiac patients or they are limitedly capable of load toleration [12,13].

These are patients with anticipated latent cardiac failure systolic dysfunction without symptoms at rest, a history of dyspnea under lighter and heavier load, arterial hypertension, left ventricular hypertrophy, arrhythmias in ECG, and roentgenographic findings of increased heart volume. In patients with cardiac enlargement and decreased cardiac reserve during the load test of class II and III (NYHA classification) [11], the prophylactic therapy with low medigoxin doses (Lanitop "Pliva") was carried out 3-5 days before hip operation and 5 days after operation or longer, depending upon the indications [14,15]. For medigoxin administration, estimation of serum digoxin levels was done by radioimmunoassay by commercial kits supplied by Abbot. The digoxin (medigoxin) concentration was measured on a sample drawn 5 hours after oral dose of digoxin in order to find out the concentration in a state of dynamic balance. Blood for this analysis was taken from the vein in the quantity of 2 cm and put in the test-tube with heparin with the patient in supine position. In the analysis of serum digoxin concentration a level of 0.7 to 2.5 mmol/L was considered as therapy one. In all patients the possible presence of infection, anemia, infusion, hypervolemia, renal insufficiency, arterial hypertension and tachycardia because of pain and myocardial infarction were analyzed.

Statistical analysis was performed by the χ^2 test. The significance of distribution results before and after operation was analyzed by the Stuart's test [16] which serves for examining the homogeneity of marginal distribution in data classification before and after operation.

Results

Group 1 consisted of 49/141 patients with suspected latent cardiac failure aged 63 years (range, 40-76). In group 2, there were 48/141 patients in the age of 69 years (range, 45-90) with chronic heart failure. Patients of both groups were receiving cardiac glycosides. Group 3, comprised 44/141 patients who had no heart disease and who preoperatively did not receive cardiac glycosides. Group 4 consisted of 120 patients aged 67 years (range, 40-90) who were not preoperatively randomized and did not receive cardiac glycosides. Distribution according to groups, age and sex is shown in Table 1. The mean value of heart volume of Group 1 with latent cardiac failure was 641.89 ml-m²; range, 362-917 ml-m². The increase in heart volume was found in 36/49 patients with arterial hypertension.

The results of load tests showed that 19/49 (38.7%) patients had lowered cardiorespiratory capacity, 28/49 (57.14%) patients belonged to the second class according to the NYHA classification and 21/49 (42.85%) patients who received prophylactic digitalis preoperatively to the third class. The relation between cardiac enlargement and reduced functional aerobic ability in the first group of our patients is presented in Table 2.

In 46/49 (93.87%) of the patients, the systolic blood-pressure - heart frequency product was greater than 12000 (18.19%) and 20/49 (40.81%) patients could hardly bear the load lesser than 3.6 METs. Before and after surgical procedure patients of

Table 1.

HEART CONDITION ACCORDING TO AGE AND SEX						
Group	Number (N) of patients/% N/%	Age < 65 y		Age > 65 y		TOTAL N
		N/%	N/%	N/%	N/%	
Latent heart failure	I - 49	27	55%	22	45%	49
Congestive heart failure	II - 48	17	35%	31	65%	48
Normal heart condition	III - 44	23	52%	21	48%	44
Control group	IV - 120	28	23%	92	77%	120
TOTAL		95	36%	166	64%	261
		$\chi^2 = 21.06, d.t.=3, P < 0.01$			$\chi^2 = 25.75, d.t.=3, P < 0.01$	
MED: = 65						

Table 2.

CARDIOMEGALY WITH REGARD TO THE FUNCTIONAL AEROBIC ABILITY IN 49/141 OF OUR PATIENTS											
Decrease of functional aerobic ability		Heart volume ml/m ² N/%				Number and percentage		TOTAL			
		< 550		551-700		> 900					
26-40%	moderate	4	8%	12	25%	3	6%	1	2%	20	41%
41-50%	severe	3	6%	12	25%	6	12%	2	4%	23	47%
> 51%	very severe	-		5	10%	1	2%	-		6	12%
TOTAL		7	14%	29	60%	10	20%	3	6%	49	100%

Group 1 and 2 with latent and chronic heart failure received cardiac glycosides. Plasma digoxin concentration measured before and after operation was 0.5 - 1.0 nmol/L, and 0.6 - 1.45 nmol/L, respectively. An analysis of heart frequency data of all four groups of patients from pre- and 24 h postoperative ECGs using the Stuart's test disclosed that there was a statistically significant differences between postoperative heart frequencies in patients of Groups 3 and 4 who received no cardiac glycosides. In Groups 3 and 4 frequency of postoperative tachycardia ($P < 0.05$) was also statistically significant compared to preoperative findings. In patients of Groups 1 and 2 who received digitalis glycosides there was no postoperative tachycardia ($P > 0.05$) as compared to the findings before the operation. The potassium values and renal function on which the therapy with digitalis depends was within the normal range. In all four groups of patients, there was a statistically significant postoperative depression of ST segment < 1 mm as compared to the preoperative findings and a significantly longer Q-T interval (Table 3).

By an analysis of disturbances in formation and conduction in an electrocardiogram of digitalized patients with latent heart failure before and after orthopedic operation it was established, that there was no significant difference ($P > 0.05$) between these parameters. The frequency of intraoperative and postoperative complications classified according to the Groups of our patients, is shown in Table 4.

Table 3.

Statistical significance of the difference (Stuart's test) of the heart frequency, S-T segment depression and corrected Q-T interval before and 24 hours after surgical procedure in our patients according to functional groups

Group	Heart frequency > 100/min	S-T segment depression > 1,5 mm	Corrected Q-T interval ♀ > 0,432" ♂ > 0,422"
I Latent heart failure	P > 0.05	P > 0.05	Q = 11.77 P > 0.05
II Congestive heart failure	P > 0.05	P > 0.05	Q = 4.47 P > 0.05
III Healthy	P > 0.05	P > 0.05	Q = 10.27 P > 0.05
IV Control group	P > 0.05	P > 0.05	Q = 9.48 P > 0.05

Table 4.

INTRAOPERATIVE AND POSTOPERATIVE COMPLICATIONS IN OUR PATIENTS

Complications Number (N) and percentage (%)	I Group 49	II Group 48	III Group 44	IV Group 120
Sinus tachycardia > 100/min	11 22%	12 28%	23 52%	34 28%
Sinus bradycardia < 50/min	-	1 8,0%	-	1 0,80%
Arterial hypertension	-	2 4,0%	2 4,5%	- (No date)
Arterial hypotension	-	1 2,0%	7 16%	6 5,0%
Stenocardia	3 6%	2 4%	-	- (No date)
Myocardial infarction	1 2%	-	-	-
Congestive heart failure - Myocardial decompensation	-	1 2%	-	22 18%
Pneumonia	-	2 4%	-	6 5%
Fatal pulmonary embolism	-	-	-	3 2%
Oliguria	-	-	-	5 4%
prolonged postoperative treatment	-	-	-	24 20%
Cerebrovascular insult/stroke	-	-	-	3 2,5%
Cardiac arrest during introduction into anesthesia	-	-	-	5 4%
Postoperative cardiac death	-	-	-	7 6%

Discussion

A decreased rate of morbidity and mortality in perioperative period compared to the controls is a result of preoperative estimation, selection and prophylactic treatment with digitalis of the patients with myocardial insufficiency about to undergo major surgery. The degree of momentary functional myocardial capacity during surgery and classification of cardiac load according to the NYHA nomenclature shows a significant correlation between the NYHA classification, morbidity and mortality in patients who underwent major surgery [17,18].

A good indicator of functional ability of cardiovascular system (obtained by the exercise tolerance test) is considered to be maximal aerobic capacity, respectively that load expressed in Watts, in which the heart is not capable any more to transport oxygen quantity which meets requirements of surgical load. The concept of oxygen transport and ventilation refers to the minute volume as the main determinant of maximal oxygen utilization, i.e. maximal aerobic capacity [12,13,19].

Of the patients who were included in the first group (49/141) and were without signs of heart failure at rest, with a history of dyspnoea in strain, with arterial hypertension (36/49, 73.46%) and cardiac enlargement (42/49, 85.71%), 22/49 (44.83%) were capable to tolerate only a low degree of load. All patients had reduced functional aerobic capacity and reduced cardiac reserve.

The rate-pressure product is considered to be a significant hemodynamic parameter in myocardial oxygen consumption [19,20,21]. According to the Loeb's study [19], this product is a better indicator of heart failure than the systolic pressure itself. It has been established that tachycardia as a result of stress more often leads to ischemia and heart failure than stress caused by hypertension. Objective data of exercise tolerance test could be applied in the operating-room in everyday work [19]. Efforts have been made to keep lower during the induction into anesthesia the rate-pressure product at which during ergometry ischemic pain appears, in order to prevent myocardial ischemia and its complications. The critical level of arterial systolic pressure (ASP) and heart frequency product for stenocardia is fixed - 23000 [19] in the majority of cardiac patients. Reports suggest that when surgical procedure is prolonged, ST-segment depression becomes more pronounced and if one does not intervene with lowering of arterial pressure, the myocardial pump function could be compressed and by reducing the minute volume it could lead to heart arrest. ST-segment depression in an electrocardiogram 24 hours after operation is a sign of elevated pressure of the left ventricular filling, ischemia and reduced relaxing of the myocardium.

In Groups 1 and 2 without tachycardia, ST-segment depression may be considered as the effect of digitalis glycosides and in Groups 3 and 4 with tachycardia who were not administered digitalis glycosides, as a result of ischemic heart disease, which is explained by a possible disturbed relationship between oxygen supply and demand during the operation. The ischemic ST-segment response is generally defined as a depression of the ST-segment 1 mm or more below the base line. It often occurs in patients with arterial hypertension and with an increase of diastolic arterial pressure, and is normalized by reduction of blood pressure. Arterial hypertension occurring 30-60 minutes after a large operation is often the consequence of hypoxia, hypercarbia, pain, strain with liquids and is treated causally [20,21]. Postoperative significantly longer Q-T interval ($P < 0.05$) in our patients draws attention to the possible functional changes of the myocardium, caused by acidosis, hypoxia and possible transitory anemia.

It is well known that the prolonged Q-T interval in an electrocardiogram is connected with a lethal outcome because of a malignant change in ventricular rhythm. In our study the corrected Q-T was prolonged in all groups except in Group 2 receiving cardiac glycosides for longer period of time [22-25]. When the Q-T interval in an electrocardiogram indicating electrical ventricular systole is prolonged, the recovery of excitable myocardial threads is unequal. Therefore, an impulse may meet unequally recovered ventricular muscle parts and by the "reentry" mecha-

nism lead to paroxysmal ventricular tachycardia and finally to ventricular fibrillation [26-29]. A malignant change of the heart rhythm may also appear without the prolonged Q-T interval [30]. The correlation between myocardial infarction, preoperative systolic arterial blood pressure, intraoperative hypotensive episodes, and arrhythmias, without typical pain is significant and the lethality is 50% [31,32]. Therefore, electrocardiogram recording in an early postoperative phase is recommended, when the possibility of poor outcome is the greatest. Postoperative lung oedema, myocardial infarction and ventricular tachycardia have frequency greater than 25% in the incidence of cardiac death. Patients with severe heart disease do not tolerate the use of vasodilators and it is often necessary, to apply inotropic drugs intraoperatively. Our study shows that by a selection of patients and digitalization it is possible to reduce the incidence of cardiac complications in the postoperative course. Exercise tolerance testing is an effective way to identify persons at high risk of cardiac complications. It enables an insight into the development of arrhythmias under the load and thus a choice of perioperative medical treatment. Digitalis glycosides may prevent or at least control postoperative heart frequency, i.e. tachycardia which belongs to relevant clinical symptoms of systolic cardiac failure [33]. Systolic cardiac failure may complicate postoperative treatment even in patients who do not have anamnestic data on cardiac arrhythmias [34,35].

Conclusion

Middle-aged and elderly patients with dyspnea during an effort, cardiomegaly and decreased functional aerobic capacity should be prophylactically digitalized by a dilatory saturation dose 3 to 5 days prior to major elective orthopedic surgery in order to increase inotropic heart reserves and to prevent postoperative myocardial ischemia and congestive heart failure. Preoperative treatment of patients with latent heart failure with digitalis glycosides does not only increase cardiac reserve but also reduces the negative inotropic effect of anesthetic agents and thus decreases the possibility of supraventricular and ventricular arrhythmias, i.e. heart failure.

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SAŽETAK

Profilaktička digitalizacija pred artroplastiku kuka u bolesnika tzv. starije i srednje dobi

U cilju smanjenja perioperacijskih komplikacija sa strane srca, skupina od 141 bolesnika srednje i tzv. starije dobi pred artroplastiku kuka podijeljena je u 3 podskupine. Prvu skupinu sačinjavali su bolesnici sa suspektim latentnim zatajivanjem crpne funkcije srca, u drugoj skupini bili su bolesnici sa znacima zatajivanja crpne funkcije srca, dok su treću skupinu činili bolesnici koji su imali očuvanu funkciju srca.

Svi su klinički i laboratorijski parametri analizirani prije i nakon kirurškog zahvata i uspoređeni su s podacima 120 bolesnika kojima je učinjena artroplastika kuka, a nisu prethodno kardiološki izabrani kao što im nije proveden postupak preoperativne primjene medigoksina.

U bolesnika s otežanim disanjem u naporu i s velikom sjenom srca radiološkim pregledom, učinjen je pokus opterećenjem ručnim ergometrom. Kod bolesnika sa smanjenim funkcijskim aerobnim kapacitetom i smanjenom rezervom srca, primijenjene su male doze medigoksina prije operacije. Osobita je pozornost usmjerena ka korigiranom Q-T intervalu u elektrokardiogramu kao znaku učinka digitalisa, kao i prema depresiji S-T segmenta u smislu znaka ishemijske bolesti srca kao i učinka digitalisa.

Frekvencija srca u digitaliziranih bolesnika s latentnim zatajivanjem crpne funkcije srca nije bila značajno promijenjena prije i nakon operacije, dok je u nedigitaliziranih bolesnika postojala značajna razlika. Glikozidi digitalisa mogu spriječiti i kontrolirati poslijeoperacijsku frekvenciju srca koja može biti znakom komplikacija. Učestalost perioperacijskih kardijalnih komplikacija u sve tri skupine bolesnika značajno je niža u odnosu prema poredbenoj skupini. Rezultati poredbenih mjerenja smetnji stvaranja i provođenja podražaja prije operacije, tijekom ergometrije, poslije liječenja digoksinom i nakon operacije pokazuju da su smetnje stvaranja podražaja povećane tijekom ergometrije, tijekom operacije i ranog poslijeoperacijskog perioda u nedigitaliziranih, dok nema razlike u digitaliziranih bolesnika s latentnim znacima zatajivanja crpne funkcije srca.

Bolesnike biološki (ne nužno i kronološki) starije životne dobi sa zaduhom pri naporu, kardiomegalijom i smanjenim funkcijskim aerobnim kapacitetom prije velikog kirurškog zahvata potrebno je 3-5 dana liječiti malim dozama medigoksina sa svrhom poboljšanja inotropne sposobnosti srca i sprječavanja perioperacijskih komplikacija.

SUMMARY

Prophylactic digitalization before hip arthroplasty in so called elderly and middle-aged patients

In order to reduce perioperative cardiac complications in 141 hospitalized orthopedic middle- and older aged patients scheduled for hip arthroplasty, we have distinguished three groups of patients:

- Group I** with suspected latent heart failure,
- Group II** with chronic myocardial insufficiency,
- Group III** with normal heart condition.

All observed parameters established before and after operation as well as analyzed complications, have been compared with the same parameters of 120 patients with already performed hip arthroplasty who were not cardiologically selected and medically treated with digoxin. Preoperatively, the arm exercise testing was applied in patients with dyspnoea at strain and with cardiac enlargement. Patients with impaired functional aerobic capacity and reduced cardiac reserve, before the operation received small doses of digoxin. Special attention has been paid to the values of the corrected Q-T interval in an electrocardiogram, to which the specificities of changes conditioned by the digoxin are attributed, as well as to S-T segment depression as a sign of ischemic heart disease in non-digitalized patients and digitalis effect (non toxicity)($P < 0.05$). By the preoperative use of digitalis glycosides in patients with bordering compensation in latent cardiac failure, efforts were made to increase inotropic cardiac reserve and to reduce negative inotropic effect of anesthetic agents to the myocardium and to reduce the cardiac morbidity and mortality in orthopedic patients, caused by the early ischemic cardiac disease and congestive heart failure.

Key words: perioperative complications, arm ergometry, latent heart failure, prophylactic digitalization, hip arthroplasty.

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