ORIGINAL REPORT

Effect of Inpatient Cardiac Rehabilitation on QT Dispersion in Patients with Acute Myocardial Infarction

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Abstract- QT dispersion is an indicator of lack of ventricular repolarization homogeneity and an independent predictor for ventricular arrhythmia and sudden cardiac death. In this study, we evaluated the effect of inpatient cardiac rehabilitation on QT dispersion in patients admitted to Afshar hospital CCU with diagnosis of acute myocardial infarction (AMI), including ST elevation or non-ST elevation MI. Sixty patients with diagnosis of AMI were randomly divided into two 30-subject groups. The subjects in the first group were undergone inpatient cardiac rehabilitation, and the subjects in the control group received only conventional treatments. QT interval dispersion was measured in two occasions: once in the first day of admission and once before discharge from hospital. In this study there was a significant reduction in QT dispersion in patients undergoing inpatient cardiac rehabilitation (48.4 vs. 42.4 ms, $P<0.001$), but in the control group, QT dispersion was not significantly reduced (49.2 vs. 46.2 ms, $P>0.05$). The reduction was not significantly different regarding gender. The effectiveness of the rehabilitation on the reduction of QT dispersion was not affected by such variables as age, gender, hypertension, positive family history, hyperlipidemia, type of AMI (with ST-elevation or non-ST-elevation) and left ventricular ejection fraction. Diabetes caused a resistance to the beneficial effects of inpatient cardiac rehabilitation, so as non-diabetic patients showed more reduction in QT dispersionin response to inpatient cardiac rehabilitation comparing non-diabetic patients and the difference was statistically significant.

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Keywords: Acute myocardial infarction; Cardiovascular risk factors; QT dispersion; Inpatient cardiac rehabilitation

Introduction

In recent years, developments in therapeutic methods of acute myocardial infarction (AMI) have significantly reduced patients' mortality (1,2). Although according to the results of various clinical trials, many patients after discharge from hospital will die during two years due to ventricular arrhythmias, and sudden cardiac death (3). Studies have shown that QT dispersion is a sign of local heterogeneity during ventricular repolarization (4-7). On the other hand, there are controversial reports about the improvement in physical capacity of post-AMI patients and reduction in their mortality due to arrhythmia and reduction in QT dispersion after outpatient cardiac rehabilitation (8-13). This study was designed to evaluate the effect of inpatient cardiac rehabilitation on QT dispersion among patients admitted to Afshar hospital coronary care unit (CCU) with diagnosis of AMI.

Materials and Methods

This was a double-blinded randomized clinical trial. Study population consisted of patients admitted to Afshar hospital CCU (Yazd, Iran) with the diagnosis of AMI. Patients who were not living in Yazd, those with orthopedic or rheumatologic diseases who were unable to do physical exercise and those who undergone coronary artery bypass graft (CABG) surgery during their admission were excluded from the study. Inpatient cardiac rehabilitation was performed in a 4-day course. Patients were randomly divided into two groups. Thirty patients in the case group were undergone a complete course of inpatient cardiac rehabilitation program, and

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thirty patients in the control group received only conventional treatments. QT dispersion was measured twice: once at the first day of admission and once before discharge from hospital. When the period of admission was long, QT dispersion was measured at the end of a 4-day course of rehabilitation. Inpatient rehabilitation was started for those patients who were stable at the beginning of rehabilitation (*i.e.* without recurrent or new chest pain during last 12 hours, new increase in creatine kinase or troponin I, new signs of decompensated cardiac insufficiency such as dyspnea at rest with bibasilar rales, new clear ECG changes or arrhythmias).

On admission, necessary information including demographic data, risk factors, previous admissions, lab data, result of echocardiography and exercise tolerance test, and diet was recorded. Then, physical examination included: measuring blood pressure and pulse rate, examination of lungs and heart, examination of extremities for pulse, edema, and range of motion was performed and recorded. In the case group, blood pressure, pulse rate and ECG was monitored during daily activities. Range of motion exercises were performed by a physiotherapist and other activities by a nurse. During these activities, blood pressure, pulse rate and ECG was monitored by a nurse. Any ECG changes (ST changes or arrhythmia) meant that the exercise should be stopped.

Table 1 shows the daily activities and their metabolic equivalents (METs) in patients during the 4- day period of admission after MI.

Table 2 shows the metabolic equivalents of common activities used in cardiac rehabilitation.

In the following situations rehabilitation program was progressed:

1. Appropriate heart rate increase during exercise.
2. 10-40 mmHg increase in systolic blood pressure in comparison to rest.
3. Lack of obvious ST or rhythm changes in ECG monitoring during activity.
4. Lack of cardiologic symptoms (palpitation, dyspnea, fatigue or chest pain).

The activity was discontinued in the following conditions:

1. Diastolic blood pressure ≥110 mmHg.
2. More than 10 mmHg reduction in systolic blood pressure.
3. Obvious ventricular or atrial arrhythmia.
4. Heart block (grade 2 or 3).
5. Signs or symptoms of exercise intolerance, including: chest pain, frank dyspnea, obvious ECG changes.

Other rehabilitation programs in this study included:

1. Psychology consultation: a psychologist evaluated depression, anxiety and stress in patients and educated them about these issues.
2. Nutrition consultation: a nutritionist educated the patients about the appropriate nutrition in coronary artery disease (CAD) patients.
3. Education of patients and their families about CAD, its risk factors and how to modify them, and methods of self-evaluation (*e.g.* measuring pulse rate and to be aware of symptoms).
4. Gradual inducing of a sense of confidence in patients about safety of activities and their effects on patients' improvement.

Table 1. Daily activities and metabolic equivalents in patients during the 4-day period of admission after AMI.

Activity	Metabolic equivalents	Day after admission
- Bed rest until stable	1-2	1: critical care unit (CCU)
- Then out of bed (OOB) in chair		
- Bed side commode		
- Routine CCU activity , with emphasis on self care	2-3	2: transfer to step-down unit
- Setting warm ups		
- Walking in room		
- Out of bed (OOB) as tolerated	2-3	3
- Standing warm ups		
- Walking 5-10 min in hall 2-3 times (first time with supervision)		
- Shower with seat	3-4	4
- Standing warm ups		
- Walking 5-10 min in hall 3-4 times; walking up on flight of stairs or treadmill walking		

Table 2. The metabolic equivalents of common activities used in primary cardiac rehabilitation.

Activity	Method	METs	Average heart rate response
Toileting	Bed pan	1-2	5-15 beats more than rest
	Bedside commode	1-2	
	Bedside urinal	1-2	
	Standing urinal	1-2	
Showering	Bedside shower	2-3	10-20 beats more than rest
	Tub shower	2-3	
	Shower	2-3	
Walking	Flat surface	2-2.5	5-15 beats more than rest
	2 mph (3.6 kph)	-2.9	
	2.5 mph (4.5 kph)	2.5	
	3 mph (5.4 kph)	3-3.3	
Exercise of upper part of body	Standing	-3.1	10-20 beats more than rest
	Arms	2.6	
	trunk	2-2.2	
Light leg exercises		-4.5	15-25 beats more than rest
		2.5	
Stair climbing	A set of stairs- 12 steps downward	2.5	10 beats more than rest
	Climbing	4	10-25 beats more than rest

Table 3. Educational program of MI patients in different days of admission.

Admission day	Educational subjects	Trainer
First	Make them aware of the place of admission and CCU	Nurse
	Basic explanations about their disease and treatment programs	
Second	First the preparedness of patient was assessed, when he (she) was ready: education about signs and symptoms, nitroglycerine, and managementof an emergency patient	Nurse
	Nutritionconsultation	Nutritionist
Third	First the preparedness of patient was assessed, when he (she) was ready: immunity factors, how to take care of themselves	Nurse
	Psychology consultation	Psychologist
Fourth	Necessary explanations and recommendations for discharge:	Nurse
	Drug consumption, activity level	
	Outpatient rehabilitation program	Physiotherapist

All educational materials were prepared in a package containing an educational handbook and a brochure about nutritional education. Table 3 shows the educational program for MI patients in different days of admission.

Data was analyzed using SPSS (version 13). Different steps of inpatient rehabilitation was explained for all patients and an inform consent was obtained from each patient for participation in the study.

Results

There was not any significant difference between two groups regarding the risk factors (Table 4).

In this study, mean QT dispersion at the first day of admission was 48.4 and 49.4 ms in the case and control groups, respectively. This measure at the day of discharge was 36.5 and 43.3 ms in the case and control groups respectively and the comparison showed a statistically significant reduction in QT dispersion after inpatient cardiac rehabilitation program in the case group (P=0.001), but the reduction was insignificant in the control group (P>0.05). Although mean QT dispersion at the first day of admission in females was significantly longer than males (54.2 vs. 45.4 ms, P=0.04), the effect of inpatient rehabilitation on QT dispersion was not significantly different between two genders, so the decrease in QT dispersion at discharge time was not significantly different.

Table 4. The profile of the patients participating in the study.

Risk factors		Group		*P*-value
		Case	Control	
Gender	Female	10 (33.3%)	13 (43.3%)	0.43
	Male	20 (66.7%)	17 (56.7%)	
Diabetes	Diabetic	10 (33.3%)	12 (40%)	0.59
	Non-diabetic	20 (66.7%)	18 (60%)	
Hypertension	Hypertensive	14 (46.7%)	17 (56.7%)	0.44
	Not hypertensive	16 (53.3%)	13 (43.3%)	
Family history	+	1 (3.3%)	3 (10%)	0.48
	-	29 (96.7%)	27 (90%)	
Smoking	+	7 (23.3%)	8 (26.7%)	0.77
	-	23 (76.7%)	22 (73.3%)	
Hyperlipidemia	+	11 (36.7%)	15 (50%)	0.29
	-	19 (63.3%)	15 (50%)	
Myocardial infarction	+	17 (56.7%)	11 (36.7%)	0.12
	-	13 (43.3%)	19 (63.3%)	
Ventricular ejection fraction	30<	7 (23.3%)	1 (3.3%)	0.12
	30-40	6 (20%)	5 (16.7%)	
	40-50	12 (40%)	17 (56.7%)	
	50>	5 (16.7%)	7 (23.3%)	
Age	55<	7 (23.3%)	9 (30%)	0.8
	55-65	12 (40%)	10 (33.3%)	
	65>	11 (36.7%)	11 (36.7%)	

Table 5. Comparison of mean QT dispersion at the first day of admission and at the discharge day regarding different influencing factors.

Influencing factor		Mean QT dispersion		*P*-value for comparison of mean QTD between two groups	*P*-value for comparison of the effect of intervention between two groups
		1st day of admission	discharge		
Gender	Male	45.4	36.7	0.04	0.86
	female	54.2	45		
Diabetes	-	51.2	40	0.43	0.03
	+	44.7	39.6		
Hypertension	-	49.9	38.4	0.94	0.07
	+	47.7	41.3		
Family history	-	48.2	39.3	0.29	0.94
	+	56.8	48.3		
Smoking	-	48.4	39.7	0.8	0.83
	+	49.9	40.5		
Hyperlipidemia	-	47.7	37.5	0.35	0.28
	+	50.2	42.9		
MI	NSTEMI	50.6	41.4	0.39	0.84
	STEMI	46.7	38.2		
LVEF	30<	49.4	38.8	0.73	0.37
	30-40	52.7	43.1		
	40-50	45.5	38.9		
	50>	52.8	40.5		
Age	55<	47.6	39.6	0.85	0.37
	55-65	49	37.6		
	65>	49.4	42.4		

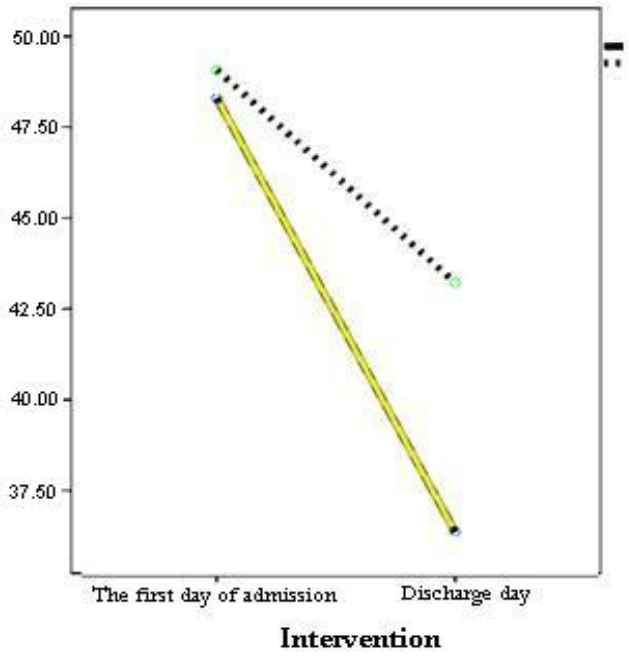

Figure 1. Comparison of mean QT dispersion at the first day of admission and discharge day in case and control groups.

There wasn't a significant difference in the reduction of QT dispersion among different age groups (*P*=0.85). Other risk factors including hyperlipidemia, hypertension, positive family history and smoking didn't influence QT dispersion and its reduction after inpatient rehabilitation program, therefore the reduction in QT dispersion was not significantly different in the patients with and without these risk factors. Statistical analyses showed as well that left ventricular ejection fraction (LVEF) didn't affect mean QT dispersion. Patients suffering from ST-elevation MI (STEMI) and non-ST-elevation MI (NSTE-MI) were compared for mean QT dispersion and its reduction after intervention, but we couldn't find a statistically significant difference in mean QT dispersion (*P*=0.39), and its mean reduction after inpatient rehabilitation (*P*=0.84) as shown in table 5 and figure 1.

Discussion

Considering the role of QT dispersion in prediction of ventricular arrhythmia and sudden cardiac death among post-MI patients, many studies have been conducted about the positive effects of inpatient rehabilitation on reduction of QT dispersion in these patients. In the current study, mean QT dispersion at the first day of admission and at discharge day was 48.4 and 43.4ms in control group and 48.4 and 36.5 ms in case group, respectively, which shows a significant reduction in case group regarding the mean QT dispersion (*P*=0.001), but this reduction was not significant in the control group (*P*>0.05). This result was consistent with the results of some previous studies (10-13).

McFarlane *et al.* didn't find a significant difference in mean QT dispersion between two genders (14), but in the current study the mean QT dispersion at the first day of admission was significantly longer in females (*P*=0.04), but the effect of inpatient rehabilitation was not significantly different between two genders which was in agreement with the results of some other studies (10-13). Comparison of mean difference in QT dispersion at the first day of admission and at discharge time among different age groups didn't show a significant difference (*P*=0.85). Other risk factors including hyperlipidemia, hypertension, positive family history and smoking didn't influence QT dispersion and its reduction after inpatient rehabilitation program. This result was also consistent with the results of some other studies (14-17).

In this study the effect of inpatient rehabilitation on QT dispersion in different age groups was similar as well and we couldn't find a significant difference between different age groups (*P*=0.07). Other similar studies also have shown a similar effect for inpatient

cardiac rehabilitation in different age groups (10-13). We found that the amount of LVEF didn't significantly influenced the mean QT dispersion which was inconsistent with the study of Malik *et al.* who showed that left ventricular dysfunction is one of the factors which increased QT dispersion (18).

We found that there was not a significant difference regarding mean QT dispersion and its reduction after inpatient cardiac rehabilitation in patients suffering from STEMI and NSTEMI (P=0.39, and 0.84, respectively).

Diabetes caused a resistance to beneficial effects of inpatient cardiac rehabilitation on QT dispersion, so as non-diabetic patients showed a significantly more reduction in QT dispersion in response to inpatient rehabilitation. It will become more important when we know that previous studies have shown that diabetes is the only risk factor which significantly increases QT dispersion; although in the current study mean QT dispersion was not significantly different between diabetics and non-diabetics. In conclusion, according to the results of the current study, inpatient cardiac rehabilitation had a significant effect on reduction of QT dispersion in patients suffering from acute MI. Except for diabetes, other modifiable and non-modifiable cardiovascular risk factors (*i.e.* hyperlipidemia, smoking, hypertension, gender and age) didn't have any significant influence on the effects of inpatient cardiac rehabilitation on QT dispersion.

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