CORONARY SINUS LACTATE EXTRACTION AND OXYGEN CONTENT IN PATIENTS WITH ANGINA PECTORIS AND NORMAL CORONARY ARTERIES UNDER ATRIAL PACING

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Between January 1991-1992, coronary sinus lactate and oxygen content was measured in 16 patients with angina pectoris but angiographically normal coronary arteries before and after atrial pacing. There were 6(37.5%) women and 10 (62.5%) men. Mean age was 50±2 years (range: 44-59).

Nine patients did not demonstrate lactate production at any time during atrial pacing (Group I) and seven patients did (Group II). Lactate extraction decreased during pacing from 0.3479±0.137 to 0.2612±0.127 in group I patients (p< 0.05). In group II patients lactate exctraction (0.1562±0.07) converted to lactate production (-0.7673±0.185), (p<0.01).

AVO_2 content differance increased from 99.13 ml/L to 101.51 ml/L after atrial pacing in group I patients (P=NS).

AVO_2 content differance increased from 98.82 ml/L to 116.03 ml/L in group II patients (p<0.01). We concluded that a positive exercise test and thallium scintigraphy shouldn't be considered false positive and appropriate studies must be conducted in patients with normal coronary arteriography and anginal pain.

Key words: Coronary sinus lactate

The increasing application of coronary angiography for the evaluation of patients with angina pectoris has led to the identification of a group of patients who experience anginal type chest pain despite the presence of normal coronary

artery anatomy by arteriography. Indeed such patients may constitute up to 18-20 percent those who have undergone elective coronary arteriography for suspected coronary artery disease[1].

Although, initially believed to be primarily an affliction of women, the syndrom has been detected with increasing frequency in men and in some studies has been found to be equally prevalent in both sexes.

The mechanism of angina in those patients has not been established. Multiple hypotheses have been proposed to explain this syndrom, but none, including small vessel disease, coronary artery spazm, oxyhemoglobin dissociation abnormalities and misinterpretation of the coranary angiogram has been substantiated in the majority of case[2,3].

Therefore, we measured the coronary sinus lactate and oxygen content in the patients with angina pectoris and normal coronary arteries under atrial pacing.

Methods

Between January 1991-1992, coronary sinus lactate and oxygen content was measured in patients with angina pectoris and angiographically normal coronary arteries under atrial pacing. There were 6(37,5%) women and 10 (62.5%) men. Mean age was 50±2 years (range 44-59).

Patient selection:

All patients had anginal chest pain. Before coronary arteriography, exercise stress test was performed to all of them, patients with positive stress test were undergone coronary arteriography. Exercise thallium-201 scintigraphy was performed to these patients with positive stress test and normal coronary arteriography.

Exercise thallium-201 scintigraphy was performed to patients with negative exercise stress test, before coronary angiography.

Coronary angiography was performed to patients with positive thallium scintigraphy.

The study group included patients with normal coronary arteriography and ventriculography. Rest ECG and echocardiography of patients were normal. None of the patients had hypertension and systemic illness. Demographic data is shown in Table-1.

Study protocol:

Patients with normal coronary arteriography and ventriculography were accepted to hemodynamy laboratory one week after coronary angiography to obtain blood samples for lactate and oxygen content measurements before and after atrial pacing. 7F brachial catheter was used for cannulation of coronary sinus via brachial vein.

Position of the catheter in the coronary sinüs was verified initially by small injection of contrast material. Catheter was positioned distally in the coronary sinus. Pacing catheter was advenced to right atrum by femoral vein. 7F pigtail catheter was advenced to the aortic valve level via femoral artery. Blood samples were taken at rest from aorta and coronary sinus. After that, right atrial pacing was started. Atrial pacing was performed with 20 beats/min increments every 3 minutes to a maximum heart rate of 160 beats/min. Each pacing rate was maintened for at least 3 minutes. Atrial pacing was started with 100 beats/min when the basal heart rate was lower than 100 beats/min. At the end of each level, blood samples were taken from aorta and coronary sinus. The blood samples were prepared and analysed for contents in whole blood of oxygen, hemoglobin, hematocrite and lactate.

Monotest® lactate fully enzymatic (Boehringer Mannheim GmbH Diagnostica) was used for lactate analysis. Heparinised blood samples for oxygen saturation and content were analyzed with a oximeter. Oxygen saturation multiplied by the theoretic oxygen carriying capacity of the patients blood, yields the calculated oxygen content of that sample. Oxygen content of blood was estimated by the formula "Hemoglobin (gr/dl) x 1.36 (ml O_2/gr Hb) x 10 x %oxygen saturation = ... ml/L".

Arterial and venous oxygen difference was calculated by[4] "arterial oxygen content — venous oxygen content".

Lactate extraction was expressed as (Lac $_{aort}$

Table 1 Patient characteristics

Mean age	: 50±2 years (44-59)
Female	: 6 (37.5%)
Male	: 10 (62.5%)
ECG (silent)	: Normal
ECHO	: Normal
Coronary angiography	: Normal
Ventricülography	: Normal (End diastolic pressure mean 9.5 mmHg [7-12])
Stress ECG (+)	: 10 (62.5%)
Stress Thallium 201 scintigraphy (+)	: 7 (43.7%)
Hypertension	: —
Diabetes	: —
Smoking	: 12 (75%)

—Lac_{cv}) / (Lac_{aort}), where Lac_{aort} and Lac_{cv} represent lactate content of arterial and coronary venous blood, respectively. Myocardial lactate production during or immediately after pacing was considered an ischemic responce. Lactate extraction was calculated from the highest coronary sinus lactate content achieved either during or immediately after pacing.

Chi-square and student's t test was used for the statistical analysis.

Results

The study included 16 patients with a mean age of 50±2 years (range: 44-59).

Nine patients did not demonstrate lactate production at any time during atrial pacing (these patients are designated as group I). Seven patients demonstrated increased lactate production (coronary sinus lactate level higher than arterial lactate level). These seven patients constitute group II. Mean arterial lactate level was 12.92±2.93 mg/dl in group I. This value was 14.67±1.64 mg/dl in group II patients (p=NS). Mean arterial lactate levels did not change at the peak atrial pacing rate (Group I: 11.86±2.86; Group II: 13.63±1.43). Lactate extraction decreased durig pacing from 0.3479±0.137 to 0.2612±0.127 in group I patients ($p< 0.05$). In group II patients lactate extraction (0.1562±0.07) converted to lactate production (-0.7673±0.185), ($p<0.01$, Figure 1, Table 2). The two groups were similar with respect to age and quality of chest pain. Left ventricular functions were normal in two groups.

AVO_2 content differance increased from 98,82 ml/L to 116.03 ml/L in Group II patients ($p< 0.01$, Figure 2, Tablo 3).

During atrial pacing, 4 patients experienced chest pain in group II. Only one patient had chest pain in group I, and waned when atrial pacing rate was increased. All patients were paced to a maximal heart rate of 160 beats/min.

Stress ECG was pozitive in 5 of 9 patients in group 1, and in 5 of 7 patients in group II (p=NS, Table 4).

Exercise thallium scintigraphy was positive only in one patient in group I. Whereas, it was positive in 6 patients in group II ($p< 0.01$, Table 5)

Discussion

Some investigators demonstrated that the reason of the anginal chest pain was coronary artery spasm in some patients with a normal coronary arteriography. But, coronary artery spasm can not be induced in some patients and anginal pain can not be relieved by nitroglyserin infusion[1].

Therefore, several investigators begin to research the cause of the anginal chest pain in patients with normal coronary arteriography. It

Table 2.

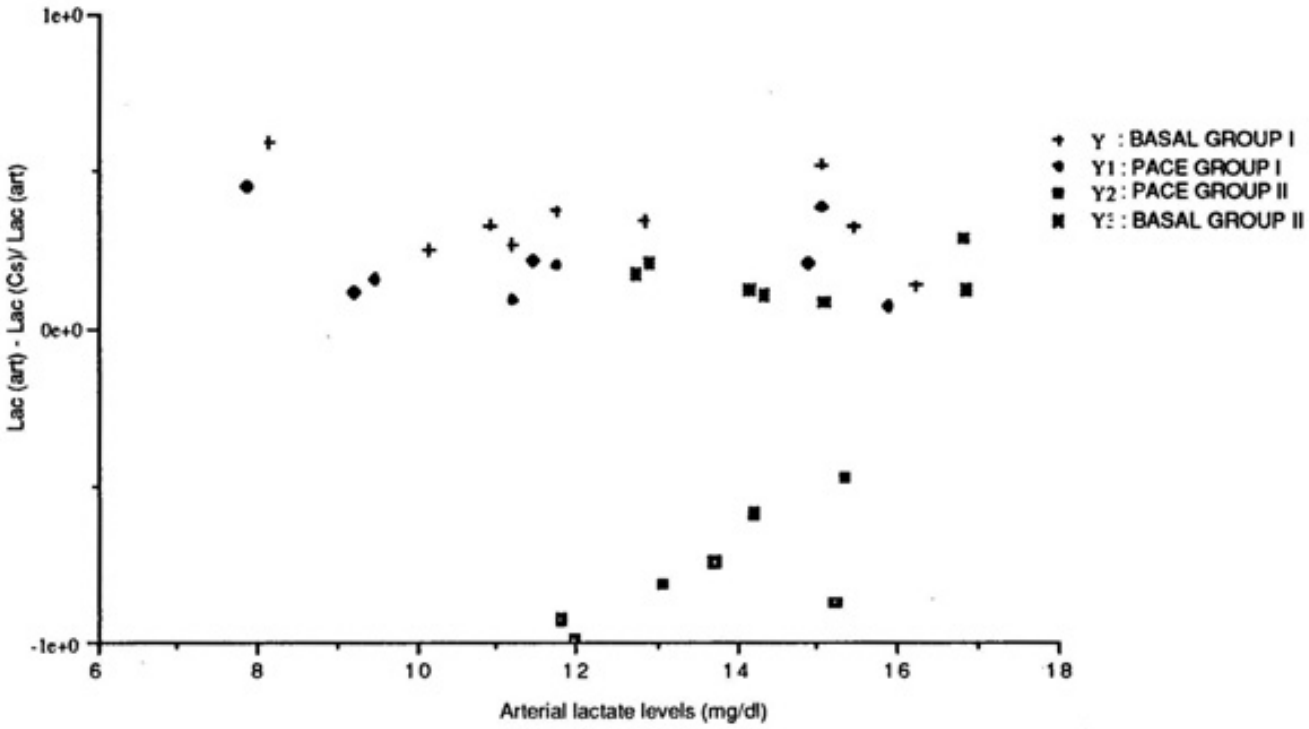
Table 2: Lactate level and O2 saturation during atrial pacing

	LACTATE LEVELS (mgr/dl)										O2 SATURATION (%)					
	Coronary Sinus					Aort					Coronary Sinus					Aort
	CoL	C1L	C2L	C3L	C4L	AoL	A1L	A2L	A3L	A4L	CoO2	C1O2	C3O2	C3O2	C4O2	AoO2
1-	10.48	9.065	10.114	11.2	11.69	15.45	14.66	12.123	14.89	13.96	33.2	28.9	29.2	29.9	30	95.2
2-	14.685	17.45	21.123	26.42	28.407	16.65	14.25	13.72	14.1	5.237	34.3	30.2	29.1	27.1	23.4	94.1
3-	13.99	13.114	13.871	14.066	14.72	16.234	15.37	14.24	15.17	15.9	37.2	33.1	34	34.4	35	94
4-	8.171	7.943	8.72	9.01	9.291	16.962	13.262	15.066	14.22	13.912	36.4	32.6	31.9	31	35	93.8
5-	12.479	13.306	18.31	20.123	23.614	14.168	12.819	13.03	12.217	13.066	35.4	30.2	29.8	27.3	27	96.2
6-	7.309	7.203	8.136	7.912	8.02	10.89	9.2	8.452	7.645	8.92	39.1	35.1	34.8	35	37	95.5
7-	3.31	3.55	4.124	3.823	4.35	8.14	6.43	7.165	7.04	7.86	34.5	31	32.1	32.3	33	95.8
8-	10.21	14.59	18.98	22.62	21.96	12.89	11.02	9.96	10.694	11.79	37.6	33	31.2	29.6	25.3	94.1
9-	8.42	8.22	7.864	8.01	8.96	12.83	9.66	9.45	11.43	11.03	38.6	34.4	33.2	33.9	34.1	96
10-	7.59	7.44	7.02	7.514	7.99	10.14	8.45	9.12	9.01	9.45	36.8	32.1	32.6	31.9	33.1	93.5
11-	12.84	14.281	18.1	21.17	23.82	14.36	12.45	19.845	12.724	13.72	38.1	33.2	32.4	30.6	28.3	94
12-	10.51	17.307	21.158	23.79	22.69	12.72	9.862	10.127	10.18	11.97	37.2	32.6	30.2	29.6	28.8	93.2
13-	8.28	6.12	9.38	7.696	8.88	13.11	9.565	10.272	9.72	11.73	39	35.3	34.8	35.1	37	97
14-	12.07	18.131	21.01	22.43	22.55	16.84	13.31	14.164	13.96	15.34	39.2	33.2	31.4	30.3	29.2	95.6
15-	13.82	16.11	18.732	22.54	20.441	15.1	12.73	14.21	13.86	14.01	38.7	31.6	31.2	29.8	28.6	95.6
16-	9.17	7.632	10.12	8.912	9.13	12.5	10.66	9.88	10.06	11.18	36.9	34.1	34.3	33.7	34.4	94.7

Table 3: AVO2 content difference and lactate extraction

	Age/gender	Exercise Duration	ST Deviation > 1 mm	Exercise Beat/min	Exercise BP mmHg	Thallium scintigraphy Defect no	Maximal Atrial Pacing rate	AVO2 difference (%)		Lactate Extraction	
								Basal	Maximal	Basal	Maximal
1	44/F	9'	—	170	182/91	—	160	62	65.2	0.32	0.21
2	54/M	7'. 4"	+	150	166/89	2	160	59.8	70.7	0.1183	-0.8078
3	48/M	8'. 3"	+	150	165/85	—	160	56.8	59	0.138	0.0742
4	51/F	6'. 4"	+	135	163/87	—	160	57.4	58.8	0.5183	0.3831
5	59/M	9'	—	165	169/88	2	160	60.8	69.2	0.1194	-0.8078
6	49/M	7'. 27"	+	150	170/92	—	160	56.4	58.5	0.3297	0.1163
7	47/F	6'. 42"	+	145	167/83	—	160	61.4	62.8	0.5934	0.4466
8	56/M	6'. 28"	+	140	171/90	1	160	56.5	68.8	0.2079	-0.9186
9	55/M	5'. 32"	+	140	157/87	—	160	57.4	61.9	0.3437	0.2161
10	50/F	8'. 48"	—	160	160/90	1	160	56.7	60.4	0.2515	0.1545
11	46/M	10'. 30"	—	170	183/93	3	160	55.9	65.7	0.1058	-0.7362
12	53/F	7'. 03"	+	150	159/89	2	160	56	64.4	0.1737	-0.9875
13	45/M	7'. 35"	+	155	170/94	—	160	58	60	0.3684	0.2003
14	57/F	6'. 15"	+	140	173/89	—	160	56.4	66.4	0.2833	-0.47
15	52/M	8'. 45"	—	160	186/87	2	160	56.3	66.4	0.0848	-0.5862
16	48/M	9'. 58"	—	165	190/91	—	160	57.8	60.3	0.2664	0.0948

Figure 1. Lactate extraction.



was demonstrated that atypical anginal chest pain can be induced by changing the coronary blood flow and some of these cases had ischemic ST-T changes. Exercise stress test positivity can be shown in only 20 persent of these patients[6,7]. The low sensitivity of the electrocardiogram for detecting ischemia probably is caused by the mild ischemia in such patients, and possible by the existence of a diffuse ischemia obviating the development of a net electrical vector. Diffuse pattern of ischemia can be shown by exercise thallium 201 scintigraphy and positive exercise thallium 201 scintigraphy can not be considered false positive merely because coronary angiography discloses no epicardial coronary artery disease. The possibility of microvascular angina must be raised and appropriate studies must be conducted. Most of the patients with positive stress test, who are misinterpreted as false positive, may actually be experiencing myocardial ischemia by microvascular dysfunction[8,10,11,12].

In spite of normal coronary blood flow and oxygen extraction, it was shown that myocardial lactate production was increased by atrial pacing in some patients with atypical chest pain [13].

Investigations in the patients with microvascular angina disclosed that[14]:

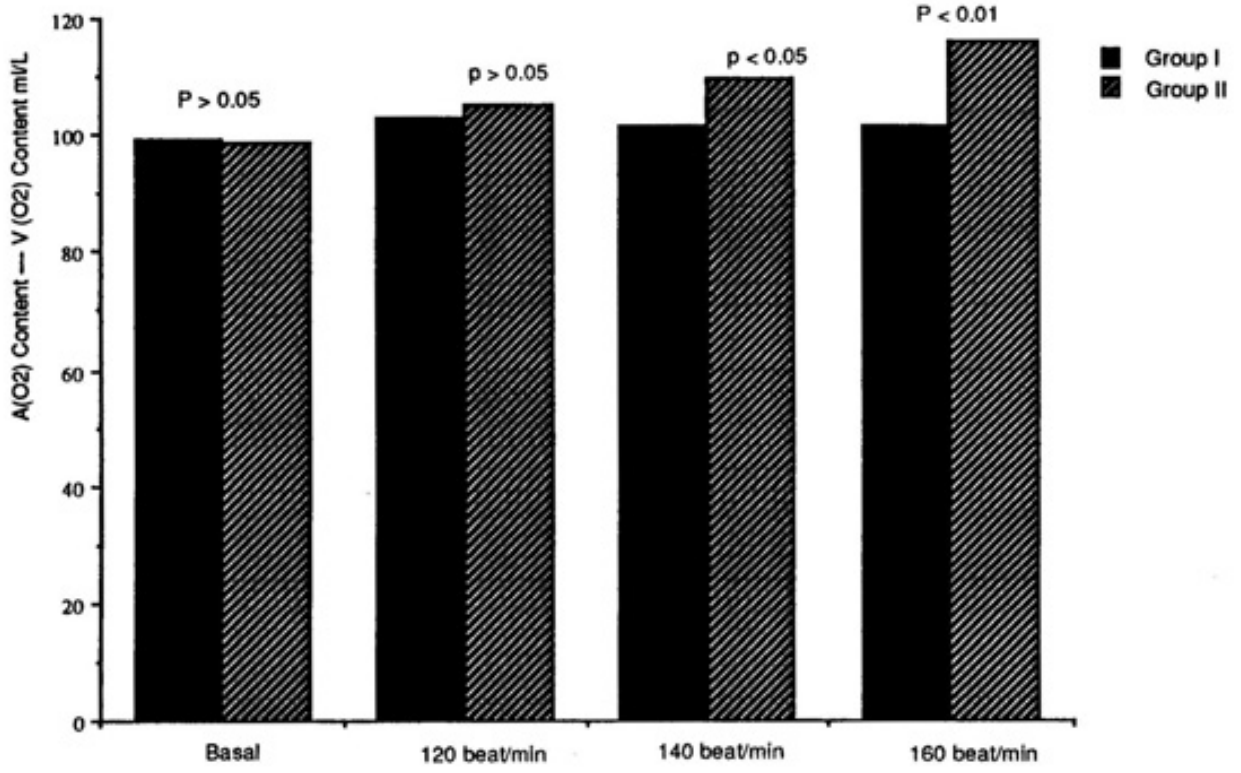
Table 4. Stress ECG results

Groups	Stress ECG	
	+	-
Group I	5	4
Group II	5	2
p> 0.05		

Table 5. Stress Thallium 201 scintigraphy

Groups	Stress Thallium 201 scintigraphy	
	+	-
Group I	1	8
Group II	6	1
p< 0.01		

Figure 2. AVO2 content differance



1. Coronary flow increased lesser and coronary resistance decreased lesser in responce to the pacing,
2. Myocardial oxygen extraction increased during pacing, which was indicated by widening of the AVO_2 differance,
3. Lactate consumption increased lesser during pacing,
4. Left ventricular end diastolic pressure rose to a greater extent,
5. Coronary resistance fell lesser in responce to dipyridamole,
6. Dipyridamole frequently precipitated the patients characteristic chest pain.

It was demonstrated in this study that lactate consumption decreased and A-V O_2 differance widened during pacing in some patients. The results of patients with positive exercise thallium 201 scintigraphy were more significant than others.

It was concluded that a positive exercise test and thallium scintigraphy shouldn't be considered false positive and appropriate studies must be conducted in patients with normal coronary arteriography and chest pain.

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