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Body Surface Potential Mapping (BSPM) before and after Percutaneous Transluminal Coronary Angioplasty (PTCA)

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Summary

The departure index area of departure maps before and after the PTCA procedure was evaluated in 10 randomly chosen patients with clinically significant ischaemic heart disease . The body surface mapping system CARDIAG 128.1, (ZPA Prague-Čakovice) was used. The departure index was calculated using Kubota's formula. The departure indexes of the ST-T interval and departure maps of 36 ms and 80 ms intervals from the J point were followed. A decrease of the departure index area was considered as a sign of successful PTCA. A correct classification was made in 6 patients out of 9 (66 %) with successfully performed PTCA. The identification of one patient with unsuccessful PTCA procedure was also correctly determined. The overall correlation between the effect of PTCA and the departure index area change was 7 out of 10 (70 %). The authors consider this method to be a useful non-invasive method for identifying of successful or unsuccessful PTCA in patients with coronary artery disease.

Key words

Body surface potential mapping – Coronary angioplasty – Ischaemic heart disease

Introduction

Departure maps are one of the possible methods for evaluating body surface potential mapping. Departure maps are constructed according to the potential distribution below the mean normal range, which is determined by averaging the potential of normal control values in each lead point on the body surface.

The concept of departure maps has been appearing for several years. Hayashi *et al.* (1980) studied the instantaneous subtraction maps in patients with acute myocardial infarction. They found that the area with a negative potential value less than 0.4 mV corresponded to areas of changed left ventricular wall motion determined by ventriculography.

Kubota *et al.* (1984) proposed a formula allowing the calculation of the departure index for a given time interval in each lead point

$$Di = (Xi - Mi)/SDi$$

where Xi represents the potential time integral value of a patient, Mi is the potential time integral value of the mean of control healthy subjects and SDi is the standard deviation. The departure area is equal to the area of the departure index less than −2 which is considered as a positive result for electrophysiological abnormality. Malková *et al.* (1990) proved that the departure maps in the 24th ms from QRS onset and the departure maps from 160th ms interval before T wave offset have had a statistically significant relationship with the alteration of the left ventricular kinetics determined by left ventriculography and by 2D-echocardiography.

Cahyadi *et al.* (1991) reported a follow up of the efficacy of percutaneous transluminal angioplasty using body surface potential mapping (BSPM). There were 30 patients in their study, 19 cases with myocardial infarction and 11 cases with angina pectoris. These authors performed BSPM using a body surface mapping system (Fukuda Denshi) and they used Kubota's formula (Kubota *et al.* 1984) for determining departure maps. They carried out a dynamic follow up of potential time integral QRS, ST-T and QRST departure maps, following the general rule that BSPM, which registers most the potentials in the thorax, permits the detection of almost all

electrophysiological changes. They reflect a change in the delivery of energetic substrates after the revascularisation procedure. Cahyadi *et al.* (1991) showed that the most significant change was found in the ST-T departure maps. This departure area significantly decreased during the first week after the surgery. The reduction of the departure area showed a marked change up to 6 months. The change of QRST departure maps had the same trend but it was less marked. The QRS departure area had an opposite tendency. Among the patients with restenosis, an increase of the departure map area of ST-T and QRST reappeared. The area of QRS departure maps did not change. These described changes were found in almost all of the myocardial infarction patients. The changes were not marked in angina pectoris patients. The authors proposed to use the method of QRS departure maps, ST-T departure maps and QRST departure maps for the non-invasive monitoring of the efficacy of percutaneous transluminal coronary angioplasty and for the detection of restenosis. The obtained results corresponded well with other non-invasive methods such as myocardial scintigraphy and stress test.

We attempted to establish the reproducibility of this method in our own group of patients using a different equipment.

Material and Methods

Ten patients were randomly chosen from a group of 150 patients in whom PTCA was performed. The study group involved 8 men and 2 women of average age 46±5 (41-55) years. Healthy subjects in the control group involved 18 persons aged 30±6 (23-60) years. BSPM was performed immediately before and 1–3 days after PTCA intervention using CARDIAG 128.1. (ZPA, Čakovice, Prague, Czech Republic). The system works with 96 electrodes. A special program was prepared for the determination of the departure maps using Kubota's formula. Area of the departure index less than −2 was considered as a sign of the abnormality. The decrease of departure index area was evaluated as a positive sign of successful PTCA. Unsuccessful PTCA was characterized by an increase of departure index area.

Echocardiography, the stress test and BSPM were performed in all patients. Coronarography was performed one month before and immediately after the PTCA procedure.

Symptom-limited bicycle ergometry was performed 1–3 days before and one week after PCTA. We followed up ST-T interval departure maps and departure maps at 36 ms and 80 ms intervals from the J point.

Table 1
The results of clinical and X-ray investigation and of PTCA using the symptom-limited stress test performed before and one week after PTCA.

Patients		Diagnosis	Stenosis	Efficacy PTCA	Stress test						
					Before PTCA			After PTCA			
					W	d.ST	AP	W	d.ST	AP	Conclusion
1.	H.M.	QIM As	RIA1	+	120	0.3	+	120	0.3	+	(−)
2.	U.Š.	QIM As	RIA1	+	120	0	+	200	0.1	−	(+)
3.	S.G.	QIM As	RIA1	+	120	0	+	160	0	+	(+)
4.	D.J.	QIM As	RIA1	−	120	0	−	80	0	−	(−)
5.	H.J.	QIM	ACD	+	80	0	+	120	0	−	(+)
6.	S.M.	non-Q As	RMS	+	80	0.4	+	80	0.2	−	(+)
7.	L.M.	non-Q As	RIA2	+	120	0	−	120	0	−	(−)
8.	R.J.	non-Q As	RMS	+	120	0.2	+	200	0	+	(+)
9.	F.H.	AP	RD	+	80	LBBB	+	80	LBBB	+	(−)
10.	P.M.	AP	RIA	+	200	0.2	−	200	0.2	−	(−)

Dg - clinical diagnosis, RIA - ramus interventricularis anterior, ACD - arteria coronaria dextra, RMS - ramus marginalis sinister, RD - ramus diagonalis, + successful PTCA, − unsuccessful PTCA, d.ST - depression of ST segment in mV, AP - angina pectoris, +/− the sign is present/absent, (+): successful PTCA stress test, (−): unsuccessful PTCA stress test sign.

Table 2
The changes of departure areas following the PTCA procedure.

Patients		Efficacy PTCA	DI ≤ −2, (% of whole map plan) ST36 Before	ST36 After	ST80 Before	ST80 After	ST-T Before	ST-T After	
1.	H.M.	+	0.9	0	1.4	0	2.1	0.9	(+)
2.	U.Š.	+	4.1	4.1	10.2	4.7	21.2	11.5	(+)
3.	S.G.	+	0	0	0	0	2.5	0.9	(+)
4.	D.J.	−	0.9	30.1	0.9	16.8	0	5.9	(−)
5.	H.J.	+	12.9	0	16.9	0	10.6	6.7	(+)
6.	S.M.	+	6.9	0	13.7	0	16.9	0	(+)
7.	L.M.	+	0	0	0	0	0	0	(−)
8.	R.J.	+	2.5	0.9	0	1.8	4.0	5.1	(−)
9.	F.H.	+	13.1	12.9	18.1	15.5	5.7	5.7	(+)
10.	P.M.	+	0	0	0	0.9	0	0	(−)

ST36 - departure area index for 36 ms interval from the J point, ST80 - departure area index for 80 ms interval from the J point, ST-T - departure area index for ST-T interval, (+): area diminished, a sign of successful PTCA, (−): area enlarged, a sign of unsuccessful PTCA

Results

The results of clinical and X-ray investigation

Seven out of ten patients had a significant stenosis of branches of the left coronary artery revealed by the coronarography. These findings corresponded with the clinical diagnosis: four cases had a Q anterior myocardial infarction and three patients had a non-Q anterior myocardial infarction. One patient had a Q posterior myocardial infarction and two patients suffered from angina pectoris. Nine out of ten patients exhibited a successful response to PTCA determined by coronarography (90 %). Haemodynamic non significant artery wall dissection occurred as a complication in one case. (Tab. 1).

The results of PTCA using the symptom limited stress test performed before and one week after PTCA

The decrease of work capacity and/or presence of depression of ST segment either or chest pain could be considered as a marker of unsuccessful PTCA. A successful PTCA was correctly determined by ergometry in five out of nine patients (55 %). We also correctly classified one patient with unsuccessful PTCA. The specificity was 60 % (Tab. 1).

The changes of departure areas following PTCA procedure were evaluated in 10 patients. The departure indexes of the ST-T interval and departure maps at the 36 ms and 80 ms intervals from the J point were followed up. In correspondence with successful PTCA, a decrease of the departure index area occurred in six out of nine patients (66 %). In the patient with an unsuccessful PTCA there was an increase in the departure index area. There was a good agreement between the methods assessing the departure area index and coronarography in 70 % (Tab. 2).

Discussion

We consider our results as encouraging and they apparently correspond to those reported by Japanese investigators. Cahyadi *et al.* (1991) studied a group of 19 myocardial infarction cases, in which changes in the size of the departure area were followed one week after PTCA. In eight cases a decrease in the departure area was encountered. Seven patients showed no changes of the departure area and the remaining four cases exhibited an increase of the departure area. In our group of eight patients with myocardial infarction we found a decrease of the departure area in five cases, no significant changes in two patients and an increase in one case. In Cahyadi's patients with angina pectoris, the changes of the departure area were not convincing. We found no significant changes in our group of two angina pectoris patients. A significant increase of the departure area was observed only in one of our patients. This increase

corresponded with an unsuccessful PTCA. Our study is limited by the small number of investigated patients and the age differences between the patients and healthy subjects. Despite these limitations of our preliminary study, we consider that the results justify further investigation of this problem.

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Reprint Requests

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