

Analysis of Perfusion Studies following Coronary Angioplasty Time Interval between Angioplasty and Perfusion. Restenosis and Ischemia

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SUMMARY

Background

International guidelines coincide in recommending that the best time to perform perfusion studies in patients undergoing coronary angioplasty is about six months following the procedure. However, cardiologists order these studies earlier, for several reasons.

Objectives

To determine reversible perfusion defects (RPDs), time interval between percutaneous transluminal coronary angioplasty (PTCA) and perfusion test, “false positive” results, ischemic burden in patients without coronary lesions and with coronary lesions in other vessels that were not treated with PTCA, and reasons for ordering a SPECT.

Material and Methods

Sixty four consecutive patients undergoing a first SPECT during the first year following a PTCA were included in two groups. Group 1: 44/64 patients (68.8%) without lesions in other coronary arteries that had not been treated with PTCA and group 2: 20/64 patients (31.2%) with lesions in other coronary arteries that had not been treated with PTCA. Mean age was 57.3 ± 10 years. Perfusion defects were assessed based on a semiquantitative visual analysis using a validated model of 17 segments.

Results

A total of 12 patients (18.7%) out of 64 presented RPDs: 9/44 (20.4%) in group 1 and 3/20 (15%) in group 2.

There were 3/12 (25%) false positive results during the first month following two balloon angioplasties and one stent implant. Two of these results were confirmed by SPECT performed later and one by coronary angiography; all patients belonged to group 1.

Time interval between PTCA and SPECT was as follows: first trimester in 33 patients, second trimester in 22 patients and third trimester or later in 9 patients.

There were no significant differences between both groups in the triple score.

SSS: 5.3 ± 3.07 in group 1 and 7 ± 4.5 in group 2; $p > 0.99$.

SRS: 1.66 ± 1.73 in group 1 and 0.6 ± 1.15 in group 2; $p > 0.99$.

SDS: 4.3 ± 1.7 in group 1 and 6.3 ± 3.5 in group 2; $p > 0.99$.

Reasons for test ordering were: control study in 49/64 (76.5%) and presence of symptoms in 15/64 (23.4%).

A positive correlation between angina and RPDs was seen in 1/9 patients (11.1%).

Conclusions

SPECT was performed in 51.5% of patients within 3 months following angioplasty.

No differences in ischemic burden among patients without coronary lesions or with lesions in other vessels were reported.

False positive results were observed in 25% of patients with RPDs who were evaluated during the first month following angioplasty.

SPECT was ordered as a control study in 76.5% of cases and there was low correlation between the presence of symptoms and studies positive for ischemia.

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Key words > Angioplasty - Perfusion - Tomography, Emission-Computed, Single-Photon

Abbreviations >	PTCA Percutaneous transluminal coronary angioplasty	SSS Summed stress score
	RPD Reversible perfusion defect	SRS Summed rest score
	SDS Summed difference score	SPECT Single photon emission-computed tomography

BACKGROUND

Myocardial perfusion single photon emission-computed tomography (SPECT) is the method of choice for functional assessment of patients after percutaneous transluminal coronary angioplasty (PTCA) whether to evaluate the presence of symptoms or to detect asymptomatic restenosis during follow-up. (1)

International guidelines coincide in recommending that the best time to perform perfusion studies in patients undergoing coronary angioplasty is about six months following the procedure, (2) as earlier studies may reveal reversible perfusion defects (RPDs) which are more related to endothelial and/or microvascular dysfunction (3-8) than to myocardial ischemia and are considered "false positive" defects.

However, cardiologists order perfusion studies earlier than recommended due to several reasons: presence of unspecific symptoms, detection of asymptomatic restenosis with silent ischemia or for functional cardiac assessment before the patient returns to work. In addition, during the last years, a new group of patients has emerged: patients with multivessel disease undergoing PTCA only of the culprit vessel. These subjects constitute a new source of "potential ischemia", (9) either due to residual ischemia after angioplasty or to progression of coronary artery disease.

The aim of this study was to analyze, in a group of patients undergoing SPECT image test after PTCA:

- The prevalence of studies with reversible perfusion defects.
- The time interval between angioplasty and the perfusion study.
- The presence of "false positive" results in early studies.
- The ischemic burden in patients with lesions in other arteries or without them.
- The reasons for ordering the SPECT, the presence of symptoms, and the correlation between symptoms with the result of the test.

MATERIAL AND METHODS

Between October 2007 and May 2008, a total of 115 consecutive subjects with a history of previous PTCA were evaluated with myocardial perfusion SPECT; 64 patients undergoing the first SPECT within one year after a successful PTCA were selected.

The population consisted of 51 men (79.6%) and 13 women (20.4%); mean age was 57.3 ± 10 years.

Exclusion criteria

- History of coronary artery bypass graft surgery.
- Failed angioplasty.
- Left bundle branch block.
- Concomitant valvular heart disease.
- Concomitant cardiomyopathy.

SPECT studies

A Tc99m Sestamibi single day protocol was performed in all cases. Sixty two patients underwent exercise SPECT scin-

tigraphy and dipyridamole was used in 2 patients. During the exercise stress test the ECG and blood pressure were monitored continuously. The test was stopped if symptoms or fatigue developed. An intravenous dose of 10 mCi of Tc99m Sestamibi was administered during peak exercise and images were acquired 30 minutes later. Attenuation correction methods were not implemented.

Perfusion defects were assessed based on a semiquantitative visual analysis using a validated model of 17 segments. (10)

We designed a 5-point scoring system:

- 0 = Normal.
- 1 = Mild
- 2 = Moderate.
- 3 = Severe reduction in photon activity.
- 4 = Absence of photon activity.

The summed stress score (SSS) was obtained by adding the scores for all 17 segments and during stress.

The summed rest score (SRS) was obtained by adding the scores of the 17 segments at rest.

The sum of the perfusion defects during stress and at rest, calculated for all 17 segments, constituted the SSS and the SRS. The summed difference score (SDS) was calculated by subtracting the SRS from the SSS.

Angioplasty and coronary angiography

Angioplasty was performed due to acute ST-segment elevation myocardial infarction in 13/64 patients (20.3%), unstable angina or non ST-elevation AMI in 26/64 (40.6%) and chronic coronary artery disease with evidence of ischemia in 25/64 (39.1%).

In total, PTCA was performed in one vessel in 46 patients, in 2 vessels in 16 patients, and 2 patients underwent PTCA of 3 vessels (mean 1.31 vessel-patients).

A stent was implanted in 82 coronary arteries; 9 vessels underwent balloon angioplasty and both procedures were performed in 7 vessels. The number of angioplasty procedures per coronary artery was as follows: 44 in left anterior descending coronary artery, 28 in the right coronary artery and 19 in the circumflex coronary artery.

Patients were divided into two groups according to the presence or absence of obstructive lesions in other vessels in which angioplasty was not performed.

Group 1: absence of lesions in other vessels, 44 patients (68.8%).

Group 2: presence of lesions in other vessels, 20 patients (31.2%).

The presence of obstructions > 50% in other main coronary arteries that had not been revascularized with angioplasty were considered for the analysis.

Statistical Analysis

Wilcoxon test was used to calculate the difference between groups.

RESULTS

Reversible perfusion defects (RPDs) were detected in 12 out of 64 patients analyzed (18.7%).

In group 1, RPDs were detected in 9/44 patients (20.4%) and in group 2 in 3/20 patients (15%).

There were no RPDs in the artery revascularized with PTCA in any patient of group 2. In this group of 20 patients, 7 had lesions in the left anterior de-

scending coronary artery that were not > 70% (Figure 1).

In group1, 3/9 patients had “false positive” results. These patients had been studied before the first 4 weeks following PTCA, 2 with balloon angioplasty and one with stent implant.

Exercise stress test was performed in all patients: two patients underwent perfusion imaging tests which were normal and coronary angiography was performed in one patient (Figures 2 and 3).

Reasons for ordering the study

In 76.5% of cases SPECT was ordered as a control study and in 23.45% due to symptoms suggestive of

ischemia: chest pain (14.0%, 9/64) and dyspnea (9.3%, 6/64).

Chest pain correlated with perfusion defects in 1/12 patients (8.3%) and corresponded to the group of patients with lesions in other coronary artery.

Time to SPECT

Time interval between PTCA and SPECT (Figure 4) was as follows: first trimester in 51.56% (33 patients; 60% with lesions in other vessels), second trimester in 34.37% (22 patients) and third trimester in 14.06% (9 patients).

There were no significant differences between both groups in the triple score (Table 1).

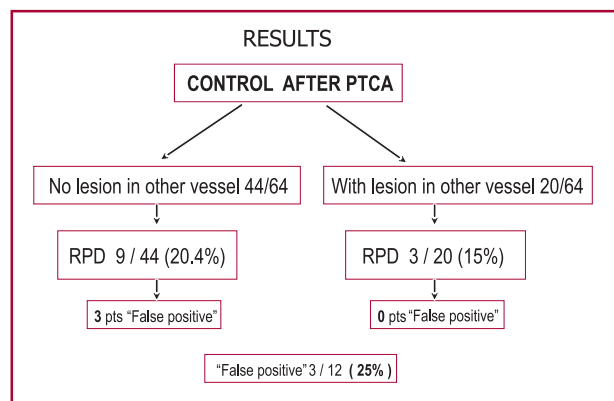


Fig. 1. Distribution of RPDs in both groups: without lesions and with lesions in other vessels

DISCUSSION

In this population we found 18.7% of RPDs, an average of all the period following angioplasty in subjects who were mostly asymptomatic.

This number differs in the published literature depending if SPECT is performed very early (11) or during the first month after PTCA as in the study by Rodés-Cabau and Candell-Riera, (12) who found an incidence of RPDs of 17%.

Zellweger et al (13) studied their patients 6 months after the procedure and detected 23% of RPDs in the artery revascularized.

Interestingly, more than half of the patients underwent myocardial perfusion tests within 3 months following PTCA, and 36% of them had lesions in other vessels.

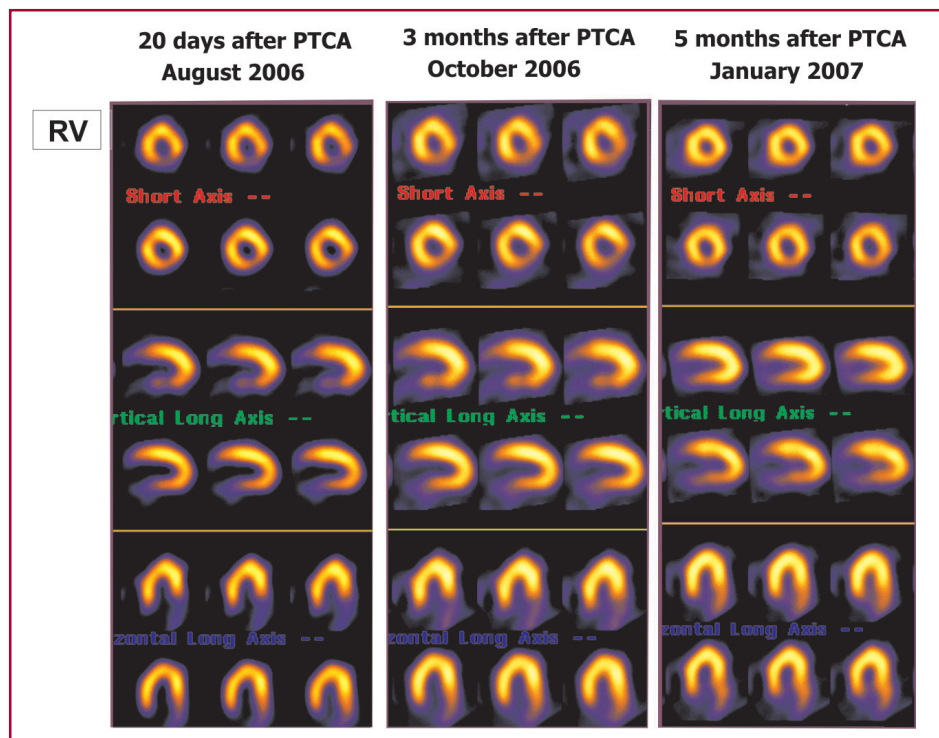


Fig. 2. Myocardial perfusion SPECT images from a 55-year old patient obtained 20 days after PTCA to the right coronary artery and circumflex coronary artery. See the perfusion defect in the inferior and inferolateral wall. RPDs persisted for 2 months; 6 months after PTCA perfusion was normal.

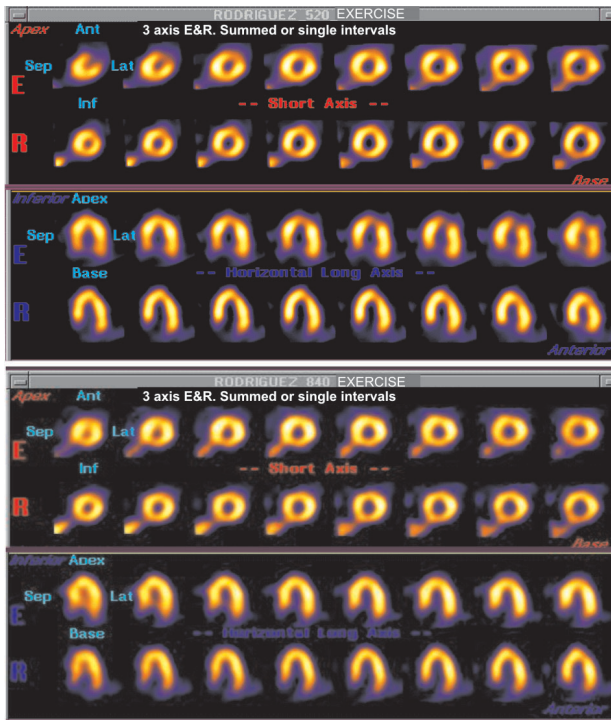


Fig. 3. Myocardial perfusion SPECT images in a 49-year old patient acquired 30 days after stent implant in the left anterior descending coronary artery and balloon angioplasty of the 1st. diagonal branch. A RPD, visible in the anterolateral wall (up row), has normalized 3 months after the procedure (lower row)

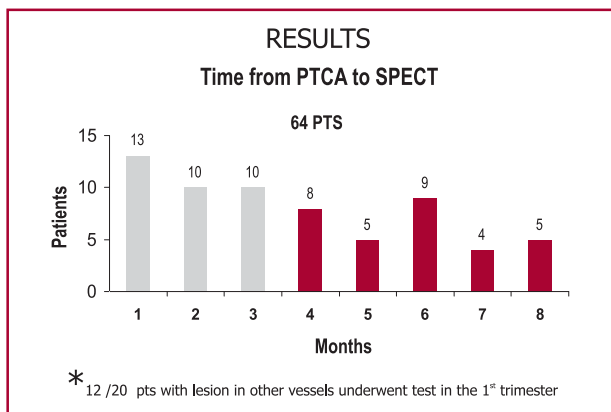


Fig. 4. Distribution of studies after PTCA in the 64 patients. The perfusion study was performed in the first trimester after PTCA in 12 out of 20 patients.

The evidence indicates that the optimal timing seems to be 6 months after PTCA; however, current guidelines show that it may “appropriate” in patients “to evaluate chest pain” and are coincidental that “medical reasons, clinical judgment and medical practice experience in a patient or in different clinical presentations” (1, 14) are also reasons which may have influence to determine the moment to perform a

Table 1. SSS, SRS and SDS obtained in both groups. Data are expressed in median and range.

	Group A (9/44)	Group B (3/20)	p >
SSS	4 (3-12)	6 (3-12)	0.99
SRS	0 (0-7)	0 (0-2)	0.99
SDS	4 (3-8)	6 (3-10)	0.99

SPECT study. There is no current information available in our country regarding the moment cardiologists of our country order functional evaluation after a successful PTCA.

In our population, 51.5% of patients were evaluated in the first trimester mainly in order to assess residual stenosis of untreated vessels.

In this case, 60% of patients with other untreated lesions underwent early evaluation and constituted 36% of the perfusion studies performed during the first trimester.

Restenosis generally occurs between the third and ninth month. (15-17) Patients with symptomatic restenosis develop angina 4-5 months after PTCA (18); angina occurring after nine months is generally due to a lesion in other site. (19, 29) The reason to order a SPECT study is that approximately 50% of patients with restenosis remain free of angina; on the other hand, 45% of patients with angina after PTCA do not have angiographic signs of restenosis.

The analysis of the ischemic burden using the SDS did not reveal significant differences between the group of patients without lesions in other vessels and the group with lesions in other coronary arteries; however, the sample size is not large enough to draw definite conclusions.

The SDS was 4.3 ± 1.7 in the group of patients without lesions and 6.3 ± 3.5 the group with lesions.

The importance of this finding might be related to the presence or absence of angina during follow-up. Zellweger et al. (20) demonstrated that patients with a SDS < 4 will probably remain free of symptoms, while those with a score > 4 are more likely to develop angina. It might also be linked to prognosis as we have demonstrated that patients with angina have greater incidence of events than patients with silent ischemia. (21)

The presence of “false positive” results in very early studies accounts for a reduced specificity of perfusion studies in the first 2 months after PTCA (3, 22), and this phenomenon is present in studies using exercise and dipyridamole. (11)

From a total of 12 positive studies, 3 had false positive results; the reason to order these 3 studies was not associated with presence of symptoms.

Myocardial perfusion studies may demonstrate RPDs in the territory of the treated artery due to microvascular or endothelial dysfunction (7, 8) which

is more frequent in balloon PTCA than with stent implant. (14)

It has been demonstrated that this phenomenon disappears within the first weeks. (3, 14)

A very early study in a patient free of symptoms who presents a RPD in the territory of the artery revascularized by PTCA should be considered a "false positive" defect.

In the current era, drug eluting stents have reduced the rate of restenosis; (23) yet, there are not enough perfusion studies to determine if RPDs related to endothelial or microvascular dysfunction are less frequent than with the use of conventional stents.

In this population we observed four cases of early RPDs, three of them in the group without lesions in other arteries; in all cases, studies were performed before 3 weeks following PTCA. In fact, two of these patients underwent a second study during follow-up; in both cases the study was normal. The third patient underwent a new coronary angiography that ruled out restenosis of the artery revascularized with PTCA. The fourth case corresponded to the group of patients with lesions in other vessels; the RPD corresponded to another territory.

In this population, 31.2% of patients had lesions in other non-revascularized arteries; RPDs were detected in only 15% of them.

It should be mentioned that the most severe lesions corresponded to the circumflex and to the right coronary arteries. Lesions in the left anterior descending coronary artery were not > 70%, probably due to the fact that more severe lesions of this artery are generally treated.

The presence of ischemia in patients with "incomplete revascularization" after PTCA has prognostic value. The study by Galssi et al. (24) reported a greater incidence of hard events, soft events and combined events in these patients, which are related with the severity of the perfusion defects.

We have also found that 76.5% of SPECT studies are ordered as control tests and only 23.5% due to symptoms. In addition, there is a low correlation between symptoms and ischemic results.

Although most patients undergoing perfusion studies were free of angina, patients with ischemia are frequently asymptomatic (22) and, conversely, silent ischemia is more frequent than angina after angioplasty. (25) Therefore, the lack of correlation between symptoms and positive studies should not be surprising.

Clinical implications

According to our findings, perfusion SPECT study in asymptomatic patients without lesions in other coronary arteries should be deferred until three months after PTCA. Patients with recurrent symptoms or with lesions in other coronary arteries may be studied earlier for functional assessment of ischemia.

Study Limitations

Our patients were referred to our center by clinical and interventional cardiologists who were anxious to evaluate the severity of the residual lesions in other coronary arteries. This fact might have produced some kind of bias in our sample.

Secondly, coronary angiography was not performed in all patients (indeed, it was not the aim of the study), and, therefore, it is not possible to determine how accurate perfusion studies are to detect restenosis; in fact, the correlation of the findings of perfusion studies with coronary anatomy still remains unclear.

CONCLUSIONS

Sixty four patients undergoing a first SPECT after a successful PTCA were analyzed. The incidence of reversible perfusion defects was 18.7%.

More than half of the patients undergo myocardial perfusion tests during the first trimester after PTCA, and 36% of them have lesions in other vessels.

Analysis of the ischemic burden shows no significant differences between absence and presence of lesions in other coronary arteries.

False positive results were observed in 25% of patients (3/12) with RPDs who were studied before the first 4 weeks after PTCA.

In this group of patients, 31.2% have lesions in other vessels, and 15% have residual ischemia.

In 76.5% of cases, SPECT studies were ordered as control studies and in 23.5% due to the presence of symptoms.

We found a low correlation between symptoms and positive results.

RESUMEN

Análisis de los estudios de perfusión posangioplastia. El tiempo entre angioplastia y perfusión. Reestenosis e isquemia

Introducción

Los consensos internacionales coinciden en señalar que el mejor momento para analizar pacientes posangioplastia con estudios de perfusión es alrededor del sexto mes. Sin embargo, por diversos motivos, los cardiólogos los indican más anticipadamente.

Objetivos

Determinar los defectos de perfusión reversibles (DPR), el tiempo transcurrido entre la angioplastia (ATC) y la perfusión, los resultados "falsos positivos", el monto isquémico en pacientes sin lesiones y con ellas en otros vasos no tratados con ATC y el motivo del pedido del SPECT.

Material y métodos

La población del estudio asignada a dos grupos estuvo conformada por un total de 64 pacientes consecutivos con primer SPECT en el año subsiguiente a una ATC. Grupo 1: 44/64 pacientes (68,8%) sin lesiones en otros vasos distintos

del de la ATC y grupo 2: 20/64 pacientes (31,2%) con lesiones en otros vasos distintos del de la ATC. La edad promedio fue de $57,3 \pm 10$ años. Se investigaron los defectos de perfusión sobre la base del análisis visual semicuantitativo con un modelo de 17 segmentos ya validado.

Resultados

Del total de 64 pacientes, se detectaron DPR en 12 (18,7%): 9/44 (20,4%) del grupo 1 y 3/20 (15%) del grupo 2.

Hubo 3/12 (25%) falsos positivos que correspondieron al primer mes posangioplastia, dos con balón y uno con *stent*. Dos se confirmaron con estudio SPECT tardío y uno con cinecoronariografía, todos del grupo 1.

El tiempo entre ATC y SPECT fue: en el primer trimestre en 33 pacientes, en el segundo trimestre en 22 pacientes y en el tercer trimestre o después en 9 pacientes.

El triple puntaje (*score*) no reveló diferencias significativas entre ambos grupos.

PSE: $5,3 \pm 3,07$ en el grupo 1 y $7 \pm 4,5$ en el grupo 2; $p > 0,99$.

PSR: $1,66 \pm 1,73$ en el grupo 1 y $0,6 \pm 1,15$ en el grupo 2; $p > 0,99$.

PSD: $4,3 \pm 1,7$ en el grupo 1 y $6,3 \pm 3,5$ en el grupo 2; $p > 0,99$.

Los motivos fueron: control en 49/64 (76,5%) y síntomas en 15/64 (23,4%).

El *angor* se correlacionó con DPR en 1/9 pacientes (11,1%).

Conclusiones

En el 51,5% de los pacientes, el SPECT se efectuó en los primeros 3 meses posangioplastia.

No hubo diferencias en monto isquémico entre individuos sin lesiones y con ellas en otros vasos.

En el 25% de los pacientes con DPR, los resultados fueron falsos positivos y los estudios se efectuaron durante el primer mes posangioplastia.

En el 76,5% de los estudios SPECT, el motivo fue el control y hubo baja correlación entre presencia de síntomas y estudios con isquemia.

Palabras clave ➤ Angioplastia - Perfusión - Tomografía de emisión computarizada de fotón simple

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Competing interests

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