Myocardial Perfusion SPECT in Right Bundle Branch Block and Left Anterior Hemiblock

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The aim of this study was to determine the diagnostic accuracy of myocardial perfusion SPECT (single photon emission computed tomography) with technetium labeling in patients with right bundle branch block (RBBB) and with left anterior hemiblock (LAH). One hundred seven patients (53 RBBB, 54 LAH) for whom coronary angiography results were available were selected. The gold standard for diagnosis was based on two coronary angiography criteria: *a)* stenosis equal to or greater than 50% in at least one coronary artery, and *b)* completely normal coronary angiography. The sensitivity of SPECT was approximately 90% in both RBBB and LAH. Specificity was 58% and 50%, respectively, for the first criterion, but was 85.7% and 87.5%, respectively, for the second criterion.

Key words: *Scintigraphy. Right bundle branch block. Left anterior hemiblock. Coronary heart disease.*

SPECT de perfusión miocárdica en el bloqueo de rama derecha y en el hemibloqueo anterior

Con la finalidad de conocer la precisión diagnóstica de la tomografía computarizada por emisión de fotones simples (SPECT) de perfusión miocárdica con compuestos tecneciados en presencia de bloqueo de rama derecha (BRD) y de hemibloqueo anterior (HBA) izquierdo, se seleccionó a 107 pacientes (53 con BRD y 54 con HBA) en los que se disponía de coronariografía. Se valoró la eficacia de la SPECT para el diagnóstico de enfermedad coronaria tomando como patrón de referencia la coronariografía según 2 criterios: *a)* estenosis ≥ 50% en al menos una arteria coronaria, y *b)* coronariografía estrictamente normal. La sensibilidad global de la SPECT se situó alrededor del 90%, tanto en el BRD como en el HBA, fuera cual fuera el criterio utilizado. Las especificidades fueron del 58 y el 50%, respectivamente, al aplicar el primer criterio. Sin embargo, cuando se consideró el segundo criterio fueron del 85,7% en el BRD y del 87,5% en el HBA.

Palabras clave: *Gammagrafía. Bloqueo de rama derecha. Hemibloqueo anterior. Enfermedad coronaria.*

INTRODUCTION

Stress myocardial SPECT (single photon emission computed tomography) is a high precision diagnostic test for coronary heart disease.[1,2] However, in patients with left bundle branch block (LBBB) specificity is limited due to low-uptake in the anteroseptal region even in the absence of stenosis in the left anterior descending artery.[3-5] Although some cases of false positives in the inferior region have been reported in patients with right bundle branch block (RBBB),[6] large series have not been described for other intraventricular conduction abnormalities.[7] The objective of this study was to determine the precision of myocardial perfusion SPECT in the diagnosis of coronary heart disease in patients with RBBB and with anterior hemiblock (AHB).

PATIENTS AND METHOD

Patients

From 1994 thru 2002 our center performed a total of 7350 myocardial perfusion SPECT studies on 347 patients with RBBB and 281 with AHB. In 94 of these, RBBB was associated with AHB. We excluded patients with previous myocardial infarction, surgical revascularization, pharmacologic stress testing alone and without coronary angiography, and enrolled 107 patients in the current study: 53 with RBBB and 54 with AHB.

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Myocardial Perfusion SPECT

All patients underwent bicycle stress testing limited by symptoms. Twenty patients were simultaneously administered 0.16 μg/kg/min dipyridamole for 4 min as exercise alone was insufficient (maximum heart rate <80% and not reaching 5 MET with absence of symptoms or positive ST segment).

We followed a brief protocol (only 1 day stress/rest) with ^{99m}Tc-tetrofosmin. Tomographic images were recorded with an Eslcint SP4 gamma ray camera with high resolution collimator, obtaining short-axis, horizontal long-axis and vertical long-axis views. Images were analyzed by 2 specialists, blinded to clinical and angiographic data, who considered them positive when a slight, moderate or severe defect was identified in at least 2 of the 3 axes or in 3 consecutive tomographic images of the same axis when these were wholly or partially reversible at rest.

Cardiac Catheterization

All patients underwent coronary angiography using Seldinger's standard technique within 12 months following SPECT (2.9±3.6 months in patients with RBBB and 3.5±3.6 months in those with AHB) assuming no complications had occurred in the interim period. At least 2 projections were obtained to evaluate both left and right main coronary arteries. Two expert observers, blinded to the tomographic results evaluated the severity of the stenosis visually.

TABLE 1. **Patient Demography Characteristics, Stress Test, and Coronary Angiography Results***

	RBBB (n=53)	AHB (n=54)
Age, years	63.4±8.6	64.5±8.7
Women	20.8%	20.4%
Indication		
Diagnostic	35.8%	29.60%
Prognostic	64.2%	70.4%
Treatment		
Beta-blockers	32.1%	31.5%
Calcium antagonists	47.2%	51.9%
Nitrates	56.6%	74.1%
Stress test		
Duration, min	7.2±3.1	6.6±2.2
MET	6.0±2	5.6±1.2
HR maximum	112±25	111±24
% HR theoretical maximum	73%	73%
SBP maximum	173±27	174±30
Angina	37.7%	24.1%
ST segment depression >1 mm	28.3%	18.5%
ST segment depression 0.5-1 mm	13.2%	3.7%
Catheterization		
Without coronary heart disease	12 (22.6%)	16 (29.6%)
Common trunk	7 (13.2%)	4 (7.4%)
Left anterior descending artery	25 (47.2%)	27 (50%)
Circumflex	26 (49%)	22 (40.7%)
Right coronary artery	26 (49%)	27 (50%)

*RBBB indicates right bundle branch block; HR, heart rate; AHB, anterior hemiblock; SBP, systolic blood pressure.

Statistical Analysis

We calculated sensitivity, specificity, positive predictive value, negative predictive value and overall value with 95% confidence intervals (CI), and positive (sensitivity/1–specificity) and negative (specificity/1—sensitivity) coefficients of verisimilitude for SPECT. To do so we use coronary angiography results as a gold standard, with 2 different criteria: *a)* presence of coronary artery disease was defined by ≥50% stenosis in at least one coronary artery, and *b)* absence of coronary artery disease was defined by a completely normal coronary angiography.

Comparison of categorical variables between groups was by χ^2 or Fisher's exact test when the value predicted was <5. Comparison of continuous variables was by Student *t* test. Values of $P<.05$ were considered statistically significant.

RESULTS

Demographics, stress test, and catheterization results are described in Table 1. Because previous conventional exercise stress testing had proved inconclusive, 34% of patients were studied for diagnostic purposes. In the remaining 66%, diagnosis of coronary artery disease had been established by coronary angiography and the indication for scintigraphy was for functional evaluation of a coronary lesion the severity of which remained unclear. In 20% of these patients, SPECT was performed during hospitalization 3 days after angina had stabilized.

The diagnostic efficacy of SPECT for the first criterion is shown in Table 2: sensitivity was 90% for RBBB and 92% for AHB; specificity was 58% and 50%, respectively. Of 5 false positives in RBBB patients, only 1 had angiographically normal coronary arteries. All but 1 of the false positives in AHB patients had coronary artery stenosis <50% (Table 3).

The diagnostic efficacy of SPECT for the second criterion is shown in Table 4: we only obtained 1 false positive in RBBB patients and 1 in AHB patients and specificity for diagnosis of coronary heart disease improved to 85.7% and 87.5%, respectively. Using this criterion, both the positive (increased pre-test probability of identifying disease in relation to a test without predictive power) and negative coefficient of verisimilitude (increased pre-test probability of identifying absence of disease in relation to a test without predictive power).

TABLE 2. **Diagnostic Efficacy of Coronary Perfusion SPECT When Coronary Heart Disease Corresponds to Stenosis ≥50%***

	RBBB (n=53)	AHB (n=54)	Total (n=107)
True positives	37	35	72
True negatives	7	8	15
False positives	5	8	13
False negatives	4	3	7
Sensitivity	90% (77-97)	92% (79-98)	91.1% (83-96)
Specificity	58% (28-85)	50% (25-75)	53.5% (34-72)
Positive predictive value	88% (74-96)	81.3% (67-92)	84.7% (75-92)
Negative predictive value	63.6% (31-89)	72.7% (39-94)	68.2% (45-86)
Overall value	83% (70-92)	79.6% (66-89)	81.3% (73-88)
Positive coefficient of verisimilitude	2.5	1.80	1.9
Negative coefficient of verisimilitude	5.8	6.25	5.9

*RBBB indicates right bundle branch block; AHB, anterior hemiblock. 95% confidence intervals appear in parentheses.

TABLE 3. **Stress Test and Gammagraphic Data of False Positives When Coronary Artery Stenosis >50% Is Considered Significant***

	Angina	ST-Segment Depression >1mm	Location of Defect	Intensity of Defect	Coronary Angiography
RBBB	No	No	Inferior	Slight	Normal
RBBB	No	No	Inferoapical	Moderate	Anomalous origin RCA
RBBB	Yes	Yes	Inferior and anterior	Moderate	RCA 40%
RBBB	No	No	Inferolateral	Moderate	RCA 30%
RBBB	No	Yes	Inferolateral	Moderate	RCA 40%
AHB	No	No	Inferior	Moderate	Normal
AHB	No	No	Inferior	Moderate	RCA 40%
AHB	Yes	No	Anterolateral	Moderate	LAD 40%
AHB	No	No	Inferior	Moderate	RCA 40%
AHB	No	Yes	Inferior	Moderate	RCA 40%
AHB	No	No	Anteroseptal	Moderate	LAD 30%
AHB	No	Yes	Inferolateral	Moderate	CX 40%
AHB	Yes	Yes	Inferolateral	Moderate	RCA 40%

*RBBB indicates right bundle branch block; RCA, right coronary artery; CX, circumflex; LAD, left anterior descending artery; AHB, anterior hemiblock.

TABLE 4. **Diagnostic Efficacy of Coronary Perfusion SPECT When Completely Normal Coronary Angiography Is Used to Define Patients Without Coronary Heart Disease***

	RBBB (n=53)	AHB (n=54)	Total (n=107)
True positives	41	42	83
True negatives	6	7	13
False positives	1	1	2
False negatives	5	4	9
Sensitivity	89.1% (76.4-96.4)	91.3% (79.2-97.6)	90.2% (82.2-95.4)
Specificity	85.7% (42.1-99.6)	87.5% (47.3-99.7)	86.7% (59.5-98.3)
Positive predictive value	97.6% (87.4-99.9)	97.7% (87.7-99.9)	97.6% (91.8-99.7)
Negative predictive value	54.5% (23.4-83.3)	63.6% (30.8-89.1)	59.1% (36.4-79.3)
Overall value	88.6% (76.9-95.7)	90.7% (79.7-96.9)	89.7% (82.4-94.8)
Positive coefficient of verisimilitude	6.2	7.3	6.8
Negative coefficient of verisimilitude	7.8	9.7	8.7

*RBBB indicates right bundle branch block; AHB, anterior hemiblock. 95% confidence intervals appear in parentheses.

DISCUSSION

Intraventricular conduction abnormalities are observed in a considerable percentage of cardiology patients, especially in those referred to nuclear cardiology units, as it may represent a diagnostic problem for conventional exercise testing. In our center, 9.5% of patients present RBBB and/or AHB. The purpose of this study

has been to determine the diagnostic efficacy of myocardial perfusion SPECT in RBBB and AHB as it has received very little attention in the literature.[6,7]

We found SPECT sensitivity to be very high, around 90%, both in RBBB and in AHB, but suboptimal (64% and 58%, respectively) when the gold standard adopted for diagnosis of coronary artery disease was the classic criterion of presence of only one coronary artery with stenosis ≥50%. However, when only those patients with healthy coronary arteries were considered strictly normal, specificity was 85.7% in RBBB patients and 87.5% in AHB patients, with a clear improvement in the coefficients of verisimilitude.

The possible functional repercussion of ischemia provoked during stress can cause contractile abnormalities and/or regional thickening due to stunning. This is visible in gated-SPECT performed at rest within 30-60 min, but it occurs only when ischemia is severe. In the absence of previous myocardial infarction (all patients in our series), gated-SPECT is useful above all when there is a non-reversible inferior defect. In this case, normal gated-SPECT at rest would support the idea that the defect may be due to diaphragmatic attenuation. In this study, we did not analyze gated-SPECT results as the technique was only used with a small proportion of our patients. However, we insisted on exercise/rest reversibility when considering gammagraphic results positive.

The anatomic-functional correlation of coronary artery lesions was not always optimal.[8,9] This meant that the chosen gold standard to determine the efficacy of the noninvasive test may be highly controversial.[10] Curiously, most studies assessing the efficacy of invasive techniques to evaluate the functional significance of angiographically slight or moderate stenosis have used myocardial perfusion SPECT as a gold standard.[11-15] Therefore, we should not be surprised that stenosis evaluated visually as <50% could be functionally significant when evaluated by means of pressure guidewires and Doppler or intravascular echocardiography.

Thus, bearing in mind that most of the possible false positives detected in our patients correspond to coronary artery stenosis <50% with possibly significant functional repercussions, we believe that the real specificity of SPECT in the presence of RBBB and AHB is very similar to that reported in patients without intraventricular conduction abnormalities.[1,2]

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