

# Goldberger's Triad in Dilated Cardiomyopathy—Can it Predict the Severity of Left Ventricular Dysfunction?

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## Abstract

*Goldberger's triad is a specific, but relatively insensitive, electrocardiographic sign for dilated cardiomyopathy. To study the correlation between the presence of this sign and the severity of left ventricular dysfunction, the electrocardiograms and echocardiographically-determined left ventricular parameters of 17 patients (mean age  $59.3 \pm 11.8$  years) with dilated cardiomyopathy were examined. Five of the patients had Goldberger's triad. We found that the mean left atrial diameter, the mean left ventricular internal diameters (both end-systolic and end-diastolic) and the mean left ventricular ejection fraction of the group of patients with Goldberger's triad did not differ significantly from the group without. Coronary angiography revealed occult coronary artery disease in 5 of 12 patients. A larger, prospective study is required to verify our finding.*

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**Key words:** *Echocardiogram, Electrocardiogram, Left ventricular function*

## Introduction

In 1982, Goldberger described a novel electrocardiogram (ECG) triad that was highly specific for patients with dilated cardiomyopathy and congestive heart failure (attributable to various aetiologic factors), with a sensitivity of 70%, a specificity of 99%, and a positive predictive value of 91%.<sup>1</sup> For unknown reasons, ventricular dilation causes the QRS vector to shift towards the transverse plane and away from the frontal plane, resulting in differential effects on QRS voltages in the chest and the limb leads.<sup>2</sup> We hypothesized that this change in the QRS vector, along with the development of Goldberger's triad, occurs in parallel with disease progression. If true, the presence of this ECG triad in patients with dilated cardiomyopathy could select for patients with more advanced disease, and hence, poorer left ventricular function. To test this hypothesis, we studied patients with dilated cardiomyopathy, and compared the left ventricular function—as assessed by echocardiographic examination—of subjects with Goldberger's triad versus those without.

## Patients and Methods

### *Study Patients*

A total of 17 patients with dilated cardiomyopathy,

and referred to one of the authors, were included in the study. They all had symptoms suggestive of cardiac dysfunction. For each patient, the symptom duration and severity, using the New York Heart Association (NYHA) classification, were recorded. Exclusion criteria were: history of anginal pain or myocardial infarction (on history or ECG), significant hypertension, chronic alcohol consumption, valvular heart disease and thyrotoxicosis.

All the patients had ECG and echocardiographic examination performed. Selected patients underwent coronary angiography at the discretion of the attending physician. They were categorized into 2 groups: group 1 consisted of patients with Goldberger's triad; and group 2, of those without this ECG pattern.

The baseline patient characteristics are summarised in Table I. The mean age of the study subjects was  $59.3 \pm 11.8$  years. The duration of symptom presentation ranged from 2 days to 15 years. There were more males than females. About one third of the patients had atrial fibrillation. Of the 12 patients who underwent coronary angiography, occult significant coronary artery disease (defined as  $\geq 50\%$  diameter stenosis of one or more major epicardial coronary arteries) was diagnosed in 5.

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TABLE I: CLINICAL CHARACTERISTICS OF THE STUDY PATIENTS (n = 17)

	Number (%)
Sex	
Male	14 (82)
Female	3 (18)
Race	
Chinese	13 (77)
Malay	4 (23)
Symptom severity	
NYHA I	1 (6)
NYHA II	1 (6)
NYHA III	1 (6)
NYHA IV	14 (82)
Electrocardiographic rhythm	
Sinus rhythm	11 (65)
Atrial fibrillation	6 (35)

NYHA: New York Heart Association Classification

### Electrocardiography

Standard 12-lead ECGs were recorded at 25 mm/s speed, and calibrated to 1 mV/cm. For each lead, the R and S wave amplitudes were measured from the PR segment to the peak of the R wave and the nadir of the S wave, respectively. Each patient's ECG was analysed for the presence of Goldberger's triad (Fig. 1), which consists of:

1. high precordial QRS voltages, defined as (SV1 or SV2) + (RV5 or RV6)  $\geq 3.5$  mV,
2. relatively low limb lead QRS voltages, defined as

total QRS amplitude (i.e. R + S)  $\leq 0.8$  mV in each of the limb leads; and,

3. poor R wave progression in the precordial leads V1 to V3  $\pm$  V4.

### Echocardiography

Detailed echocardiographic studies were performed on all patients. Measurements were made according to the recommendations and guidelines of the American Society of Echocardiography.<sup>3</sup> The left atrial diameter (LA), end-systolic left ventricular internal diameter (LVlDes) and end-diastolic left ventricular internal diameter (LVlDed) were recorded. Left ventricular ejection fraction (LVEF) was also assessed.

### Statistical Analysis

Continuous variables (including echocardiographic measurements) were expressed as mean  $\pm$  1 standard deviation. Statistical comparisons between the 2 groups were made using the Students' *t*-test. A *P* value of less than 0.05 was considered statistically significant.

### Results

Goldberger's triad was detected in 5 patients (29%). The mean ages of patients in both groups 1 and 2 were similar ( $58 \pm 17$  versus  $60 \pm 10$  years, respectively; *P* = not significant).

The echocardiographic parameters in both groups of patients are summarised in Table II. No significant difference was demonstrated in the left atrial diameter, the

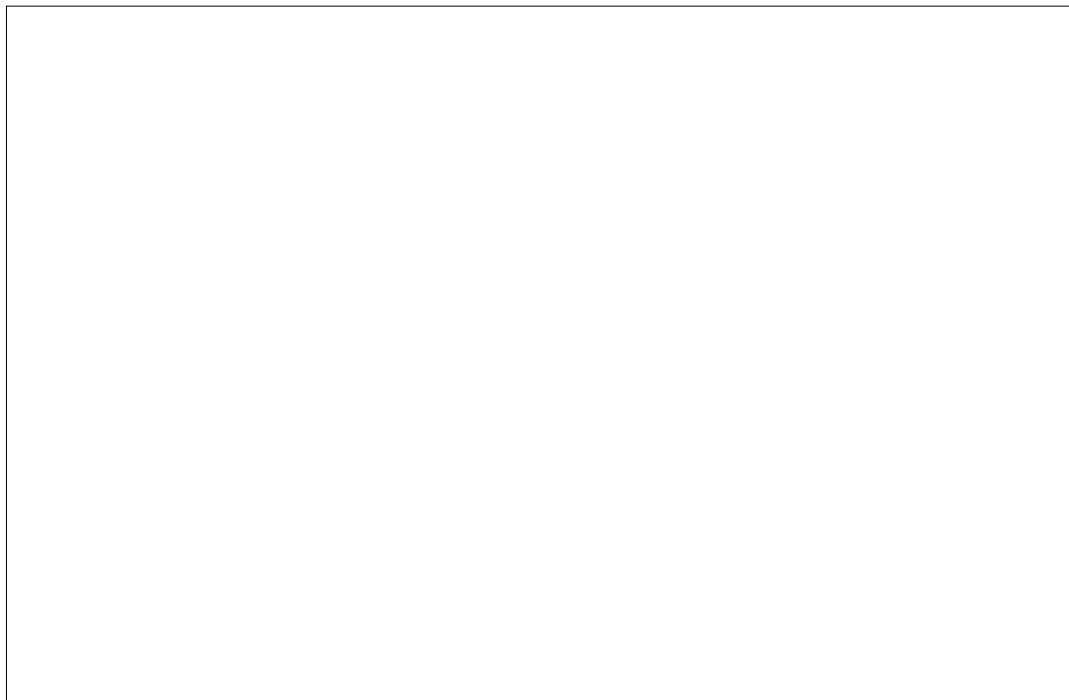


Fig. 1. 12-lead electrocardiogram showing typical features of Goldberger's triad and underlying atrial fibrillation.

TABLE II: ECHOCARDIOGRAPHIC PARAMETERS IN PATIENTS WITH (GROUP 1) AND WITHOUT (GROUP 2) GOLDBERGER'S TRIAD

Echocardiographic parameter (mean)	Group 1	Group 2	P value
LA (mm)	46 ± 6	48 ± 8	ns
LVIDes (mm)	59 ± 13	59 ± 5	ns
LVIDed (mm)	68 ± 12	70 ± 7	ns
LVEF (%)	30.2 ± 13.9	27.6 ± 9.1	ns

Values are presented as mean ± SD

LA: left atrial diameter; LVEF (%): left ventricular ejection fraction expressed as percentage; LVIDed: end-diastolic left ventricular internal diameter; LVIDes: end-systolic left ventricular internal diameter; ns: not significant

left ventricular internal diameters (both end-systolic and end-diastolic) and the left ventricular ejection fraction between group 1 versus group 2 patients.

## Discussion

Dilated cardiomyopathy is a disease of varied aetiologies. It is noteworthy that a substantial proportion of our patients had occult coronary artery disease which was evident only on angiography. This underscores the fallibility of clinical assessment and non-invasive means of diagnosing ischaemic heart disease in patients with dilated cardiomyopathy.<sup>4</sup>

Patients with dilated cardiomyopathy have protean ECG manifestations, including left ventricular hypertrophy, non-specific ST segment and T wave changes, atrial enlargement, and atrial and ventricular dysrhythmia. Attempts to correlate the surface ECG features with disease aetiology<sup>5</sup> as well as with the severity of left ventricular dysfunction,<sup>6,7</sup> have met with variable suc-

cess. Our study is the first to correlate the presence of a specific ECG sign, namely that of Goldberger's triad, with echocardiographically-determined left ventricular parameters in this group of patients.

In the present study, we demonstrated that although Goldberger's triad is a specific ECG sign for dilated cardiomyopathy, it is not reflective of the severity of left ventricular dysfunction. However, given the retrospective nature and the small size of the present study, our findings should be considered preliminary, and should be verified by a larger prospective study.

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