The Ballistocardiogram in a Free Clinic

By JOHNSON McGUIRE, M.D., GISELA HERWITZ, B.A., AND JOHN R. BRAUNSTEIN, M.D.

Of 240 patients consecutively admitted to the Cardiac Clinic of the Cincinnati General Hospital, and on whom a clinical diagnosis of heart disease was ultimately established, 204 had a ballistocardiogram taken and either an electrocardiogram, a six-foot chest plate or both of the latter two. The ballistocardiogram was evaluated (1) in terms of abnormality of pattern and (2) in degree of deviation from normal initial cardiac force. Frequency of abnormality in the various techniques is presented for the group as a whole as well as for several etiologic groups. It is concluded that for a population of this kind the frequency of abnormality in the ballistocardiogram and electrocardiogram is essentially the same, whereas it is somewhat less in the chest plate.

The electrocardiogram and the chest x-ray are two of the more popular and valuable laboratory aids in the diagnosis of heart disease. The ballistocardiogram is a relative newcomer to the field. The purpose of this paper is to compare the accuracy of the ballistocardiogram in determining the presence of cardiac disorders with that of the other two methods.

Out of 240 patients admitted to the Cardiac Clinic of the Cincinnati General Hospital, 204 had a ballistocardiogram and one, or both, of the other two tests taken. In addition, a clinical diagnosis of heart disease was ultimately established. The electrocardiograms were read in the usual manner and the interpretations classified as normal and abnormal for the purpose of tabulation. The ballistocardiogram was evaluated in terms of the quality of the pattern and the degree of deviation from normal initial cardiac force. Cardiac force was chosen as the quantitative measurement rather than cardiac output since the former can be calculated from any record regardless of the normality of the pattern. Cardiac output calculation, on the other hand, is confined to the normal pattern. The chest x-ray films were read in the usual manner; the transverse diameter of the cardiac silhouette was measured and its normality judged according to the height and weight of the patient. Again, the interpretations were classified as abnormal and normal.

The results of the comparisons are presented for the most part in histograms. This manner of presentation was chosen because the distribution of the measurements upon which the final impressions were based was not normal, for example, that of initial cardiac force was skewed. Under the circumstances, measures of cardiac function would not be expected to have a normal distribution. However, this is approximately normal when cardiac force is calculated from the tracings of a group of individuals without heart disease. For these reasons the more sophisticated statistical methods were not used, since the validity of their results would have been questionable. Instead, all five parameters were divided into normal and abnormal categories and the percentages of abnormality for any particular test calculated and plotted.

Inspection of figure 2 shows that the frequency per cent of abnormal electrocardiograms and ballistocardiographic patterns is within a few points in favor of the latter. When initial cardiac force and the electrocardiogram are compared, it is found that the difference between them is slightly in favor of the electrocardiogram. However, when pattern and force are considered as a unit and compared with the electrocardiogram, abnormality again is more frequent in the ballistic tracing. It should be noted that the ballistocardiogram and electrocardiogram read-

From the Biophysical Laboratory, Graduate School of Arts and Sciences and the Cardiac Laboratory, Department of Internal Medicine, College of Medicine, University of Cincinnati, and the Cincinnati General Hospital.

This project was supported in part by a grant from the National Heart Institute of the U. S. Public Health Service.
ings agree in 76 per cent of the cases when ballistic pattern alone is being compared; when it is combined with initial cardiac force the agreement is reduced to 58 per cent.

![Graph](image)

**Fig. 1.** Frequency distribution of per cent deviation from normal initial cardiac force. (From *The Ballistocardiogram* by John R. Braunstein. Courtesy of Charles C Thomas, Springfield, Ill.)

![Graph](image)

**Fig. 2.** Frequency of abnormalities in electrocardiogram and ballistocardiogram.

![Graph](image)

**Fig. 3.** Frequency of abnormalities in electrocardiogram, ballistic pattern and initial cardiac force. (From *The Ballistocardiogram* by John R. Braunstein. Courtesy of Charles C Thomas, Springfield, Ill.)

Division of the patient group according to diagnosis produces good agreement between results of electrocardiogram and ballistic pattern. In coronary heart disease it is 80 per cent (fig. 4). In hypertensive cardiovascular disease, it amounts to 71 per cent (fig. 5). It is interest-

![Graph](image)

**Fig. 4.** Frequency of abnormalities of electrocardiogram and ballistocardiographic pattern in coronary heart disease.

![Graph](image)

**Fig. 5.** Frequency of abnormalities in electrocardiogram and ballistocardiographic pattern in hypertensive cardiovascular disease.

ing to note here that none of the patients in the first group had normal electrocardiograms and ballistocardiograms simultaneously, but a small number of those with hypertensive cardiovascular disease had. Electrocardiographic abnormality appears about as often as abnormality of ballistocardiogram pattern in coronary heart disease. In patients with hypertensive cardiovascular disease, the ballistocardiogram pattern revealed abnormality somewhat more frequently than the electrocardiogram (10 per cent). An analysis of the findings in the other disease groups is not feasible since the points are distributed too thinly between them.

When the ballistocardiogram is compared with the x-ray films, it is found that the former shows abnormality more often than the latter (fig. 6), the difference being about 14 per cent. The evaluation of the tests is the same in 79 per cent of the cases. (Evaluation is based on pattern for one and diameter of the heart for the other.) In order to determine if any relationship existed between the initial cardiac
force and cardiac size, the findings recorded by these two means were compared (fig. 7). The results agree in only 56 per cent of the cases. Fifty-four per cent of the patients had abnormal x-ray films, but 73 per cent of them had abnormal cardiac force.

Baker, Scarborough, Mason and Singlewald reported in a recent paper that the ballistocardiogram (pattern only) was much more sensitive for detecting abnormality of cardiac function than the electrocardiogram. This is particularly true in early cardiac disease and in angina. Their data are very convincing. The discrepancy between their findings and ours could be explained on the basis of the patient material available and the selection of the cases; Baker and his associates eliminated from their study all those persons who had an enlarged heart on x-ray study and/or systolic blood pressure over 177 mm. Hg. In general, it can be said that the patients examined in the Outpatient Clinic of the Cincinnati General Hospital have fairly advanced cardiac disease, and relatively few are seen whose heart disease is still in the early stages.

Although our data are not as clear-cut as those of the Johns Hopkins group, a slight but consistent trend can be observed. In general, it can be said that for a group of patients like those upon which this study is based, the ballistocardiogram and the electrocardiogram are equally good diagnostic technics. Although they deal with different phases of cardiac physiology, they record abnormality with about equal frequency. The comparison between x-ray findings and ballistocardiogram favors the latter, and is particularly pronounced when cardiac force and transverse diameter are the only criteria used.

REFERENCES


The Ballistocardiogram in a Free Clinic
JOHNSON MCGUIRE, GISELA HERWITZ and JOHN R. BRAUNSTEIN

Circulation. 1952;6:408-410
doi: 10.1161/01.CIR.6.3.408

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1952 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on
the World Wide Web at:
http://circ.ahajournals.org/content/6/3/408

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally
published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not
the Editorial Office. Once the online version of the published article for which permission is being
requested is located, click Request Permissions in the middle column of the Web page under Services.
Further information about this process is available in the Permissions and Rights Question and Answer
document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org//subscriptions/