Pre-Excitation as a Cause of Appearance and Increased Intensity of Systolic Murmurs

By John M. Bergland, M.D., Warren R. Rucker, M.D., John T. Reeves, M.D., and Borys Surawicz, M.D.

Association of cardiac murmurs with the Wolff-Parkinson-White (WPW) syndrome has been reported by several investigators.1-7 In the reported cases, however, the murmurs were not directly attributed to hemodynamic alterations produced by pre-excitation.

This communication describes three patients with systolic murmurs related to pre-excitation. In one patient the murmur was heard only when the electrocardiographic WPW pattern was present, whereas in the other two the intensity of the murmur was significantly increased when the WPW pattern was present.

Figure 1

Case 1. A. Electrocardiogram with WPW pattern. B. Lead I and two simultaneous phonocardiograms, the upper with a nominal frequency of 50 c/s and the lower 300 c/s, recorded in the fourth intercostal space at the left sternal border. Note the fourth heart sound and the decrescendo systolic (SM) murmur. R-R = 0.83 sec.; P-R = 0.15 sec.; QRS = 0.14 sec. C. Phonocardiogram following injection of 0.4 mg. of atropine sulfate intravenously. Note the decreased intensity of the systolic murmur accompanying the decrease in degree of pre-excitation. R-R = 0.75 sec.; P-R = 0.18 sec.; QRS = 0.11 sec. Note the decreased duration of delta wave, decreased R amplitude, and a more upright T wave. Paper speed: 25 mm./sec. (A) and 50 mm./sec. (B, C).

Circulation, Volume XXXIII, January 1966 131
Case Reports

Case 1

A 32-year-old white housewife was seen in the Outpatient Department of the University of Kentucky Hospital on February 15, 1965, with a history of fatigue, dyspnea on exertion, and paroxysmal tachycardia since age 12. A heart murmur was first reported at age 17. Two full-term pregnancies at ages 18 and 21 were complicated by tachycardia. For the past 10 years the patient had been treated with digitalis. Recently, attacks of tachycardia have occurred once or twice monthly and have lasted from 1 to 36 hours.

The abnormal findings on physical examination were limited to the heart. The point of maximal impulse was felt 2 cm. lateral to the left mid-clavicular line in the fifth intercostal space. The first sound was split and a fourth heart sound was heard at the lower left sternal border. A grade-II/VI decrescendo, nonpansystolic murmur was heard in the fourth intercostal space at the left sternal border. The intensity of this murmur increased slightly with inspiration. The electrocardiogram revealed a WPW pattern (fig. 1A). After intravenous administration of 0.4 mg. of atropine sulfate there was a decrease in the degree of pre-excitation, and the intensity of the murmur was greatly diminished (fig. 1B, C).

Subsequent cardiac catheterization demonstrated that the patient had Ebstein's anomaly on the basis of (1) an intracavitary electrocardiogram showing a ventricular pattern in a zone of right atrial pressure, (2) angiographic evidence of tricuspid valve displacement to the left and downward, (3) tricuspid incompetence as shown by cineangiograms and right atrial pressure contour, and (4) numerous bouts of supraventricular tachycardia. In the presence of a WPW pattern the upstroke of the right ventricular pressure tracing was simultaneous with that of the left.

Comment. The systolic murmur in this patient was attributed to tricuspid insufficiency. A phonocardiogram made following the intravenous injection of atropine showed that the intensity of the murmur decreased with decreasing degrees of pre-excitation. The rate was slightly more rapid after atropine. However, this could not account for the decreased intensity of the murmur, because a comparable spontaneous increase in rate without any change in the degree of pre-excitation was not accompanied by decreased intensity of the murmur.

Case 2

A 61-year-old Negro farmer was admitted to the University of Kentucky Hospital on February 20, 1964, complaining of weakness and dyspnea of 5 years' duration. For the past 5 years the patient had been treated for mild hypertension.

Physical examination revealed a pulse rate of

![Figure 2](http://circ.ahajournals.org/)

**Figure 2**

Case 2. Electrocardiogram with intermittent WPW pattern.

---

**Figure 3**

*Case 2. Lead II and two simultaneous phonocardiograms with a nominal frequency of 50 c/s (upper) and 300 c/s (lower). Note the relation of the degree of pre-excitation to the intensity of the systolic murmur. Recording sites: apex (A); fourth intercostal space left of sternum (B); third intercostal space left of sternum (C and D). Strip D is a direct continuation of the strip C.*
92 per minute, blood pressure of 170/90 mm. Hg, and a respiratory rate of 20 per minute. Positive findings were limited to the heart. The point of maximal impulse was palpated in the fifth left intercostal space, 3 cm. to the left of the midclavicular line. There was a grade-IV/VI pansystolic murmur at the apex.

The chest roentgenogram confirmed moderate cardiac enlargement, chiefly left ventricular. The electrocardiogram showed an intermittent WPW pattern (fig. 2). The phonocardiogram demonstrated that the intensity of the murmur at the apex and at the left sternal border increased with increasing degrees of pre-excitation (fig. 3A-D).

Cardiac catheterization revealed normal right heart pressures. The left ventricular end-diastolic pressure was 10 mm. Hg. Ventriculography revealed mild mitral insufficiency.

Comment. The systolic murmur in this patient is attributed to mitral insufficiency. It had maximal intensity at the apex and was widely transmitted. The etiology of mitral insufficiency in this case is uncertain. It could be a result of left ventricular enlargement caused by hypertensive heart disease. The increased intensity of the murmur with increasing degree of pre-excitation suggests that the latter may increase the regurgitant flow through the mitral valve.

Case 3

A 20-year-old housewife was admitted to the Psychiatric Service of the University of Kentucky Hospital on June 7, 1963, because of depression. Past medical history and physical examination were not remarkable with the exception of a grade-III/VI systolic murmur heard in the second left intercostal space. The electrocardiogram showed an intermittent WPW pattern (fig. 4A, B). Figure 5 shows that the murmur was present only when the WPW pattern was recorded. Cardiac catheterization performed on June 23, 1963, revealed normal pressures in the right and left heart. The onset of right ventricular contraction preceded that of the left by 0.03 second (fig. 6A). After administration of atropine sulfate the pre-excitation was abolished, the murmur disappeared, and the onset of right ventricular contraction followed that of the left by 0.05 second (fig. 6B).

Figure 4

Case 3. A. Electrocardiogram with WPW pattern. B. Lead V5 and an esophageal lead demonstrate the intermittence of pre-excitation. Paper speed: 25 mm./sec. (A), and 50 mm./sec. (B).

Figure 5

Case 3. A. Lead II and phonocardiogram recorded at the second left intercostal space. Note the systolic murmur (SM) in the presence of WPW pattern. B. Lead II and phonocardiogram recorded in same area as A, showing absence of murmur in the absence of WPW pattern. Paper speed: 50 mm./sec.
SYSTOLIC MURMURS

Figure 6

Case 3. A. Right (RV) and left ventricular (LV) pressures, lead II and phonocardiogram (PCG). Note the early onset of right ventricular pressure rise and systolic murmur in the presence of WPW pattern. B. Following injection of 0.4 mg. of atropine sulfate the WPW pattern and the murmur disappear. The onset of right ventricular pressure rise is 0.05 sec. later than in A. Time lines are at 0.1 sec.

Comment. In the absence of clinical and hemodynamic evidence of heart disease the murmur is considered "functional" and probably innocent. It occurred only with pre-excitation.

Discussion

The literature contains numerous reports of patients with the WPW pattern or syndrome who had cardiac murmurs. The original description of 11 patients with pre-excitation by Wolff, Parkinson, and White in 1930 includes two with systolic murmurs. Of nine patients reported by Littman and Tarnower, two had apical systolic murmurs. Lyle reported a patient with the WPW syndrome who had an intermittent systolic murmur present at the apex and base, but no comments were made on the relation of the murmur to the electrocardiographic pattern. Wolff's recent review mentions the occurrence of "benign murmurs." In 109 subjects with a WPW pattern and without evidence of heart disease, Averill et al. found "insignificant systolic murmurs" in five. In one patient with a WPW pattern and premature contraction of the right ventricle shown by cardiac catheterization, Aravanis et al. attributed a systolic murmur along the left sternal border, which increased with inspiration, to functional tricuspid insufficiency. Westlake et al. studied a kinship where 13 of 39 persons had a WPW pattern. Five of those with a WPW pattern had cardiac murmurs.

In one of our patients a typical functional murmur at the base was present only during pre-excitation, which suggests that the pre-excitation may alter the hemodynamics and thus produce the murmur. McKusick suggested that a possible explanation for innocent murmurs in the pulmonary area is trigonoiodation of the pulmonary cusps, resulting in tight flaps that may vibrate during systole. Whether the appearance of such murmur in the presence of a WPW pattern is caused by accentuation of this mechanism by the premature contraction of the right ventricle is uncertain.

The mechanism by which pre-excitation increases the intensity of organic regurgitant murmurs is equally obscure. However, the increased intensity of the murmur of organic tricuspid and mitral insufficiency suggests that regurgitation could be increased when pre-excitation is present. Thus, the pre-excitation could possibly have an effect on the clinical course of patients with these lesions.

Summary

In three patients with a Wolff, Parkinson, White (WPW) pattern and systolic murmur, the murmur disappeared or decreased in intensity when the WPW pattern disappeared or became less pronounced. The accentuation of the murmur of tricuspid and mitral insufficiency suggests that pre-excitation may be responsible for an increase in regurgitant flow in patients with these lesions. A "functional" murmur may appear only during pre-excitation. The appearance or increased intensity of the murmur is presumably related to the altered patterns of ventricular activation and contraction accompanying the WPW pattern.

References

2. Littman, D., and Tarnower, H.: Wolff-Parkin-

An Eighteenth Century Cleric's Denunciation of the Medical Profession

Men of learning began to set aside experience; to build physic upon hypothesis; to form theories of diseases and their cure, and to substitute these in the place of experiments. . . . Medical books were immensely multiplied; till at length physic became an abstruse science, quite out of the reach of ordinary men.

Physicians now began to be had in admiration, as persons who were something more than human. And profit attended their employ as well as honour; so that they had now two weighty reasons for keeping the bulk of mankind at a distance, that they might not pry into the mysteries of the profession. To this end, they increased those difficulties by design, which began in a manner by accident. They filled their writings with abundance of technical terms, utterly unintelligible to plain men. . . . Those who understood only how to restore the sick to health, they branded with the name of Empirics.—JOHN WESLEY. Primitive Physic. London, The Epworth Press, 1960, p. 26.
Pre-Excitation as a Cause of Appearance and Increased Intensity of Systolic Murmurs
JOHN M. BERGLAND, WARREN R. RUCKER, JOHN T. REEVES and BORYS SURAWICZ

Circulation. 1966;33:131-136
doi: 10.1161/01.CIR.33.1.131

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/33/1/131

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/