The Atrial Contribution to the Left Ventricular Apexcardiogram

Alberto Benchimol, M.D., F.C.C.P., Jaco Fishenfeld, M.D. and Kenneth B. Desser, M.D., F.C.C.P.

Study of left ventricular function during complete heart block and ventricular pacing has demonstrated that stroke output is enhanced by a properly timed atrial systole. An atrial depolarization occurring at an optimal interval prior to ventricular contraction increases left ventricular end-diastolic volume and contractility. We report here the apexcardiographic recording from a patient who manifested pulsus alternans on physical examination as a consequence of properly timed atrial contractions.

CASE REPORT

This 65-year-old man with coronary artery disease had a permanent right ventricular endocardial pacemaker (demand type) implanted in 1970 for Stokes-Adams syncope secondary to complete heart block. During a routine follow-up physical examination on February 17, 1972, alternation of the presystolic impulse and major arterial pulses was noted. On cardiac auscultation, a third heart sound was heard during every cardiac cycle. Fourth heart sounds, however, were only heard prior to alternate beats which resulted in more prominent apical impulses and arterial pulse waves. Furthermore, each fourth heart sound was followed by a first heart sound of lower intensity. A simultaneously recorded tricuspid area phonocardiogram, apexcardiogram and lead II of the electrocardiogram clarified the mechanism responsible for these unusual physical findings. A P wave in the electrocardiogram preceded every alternate ventricular paced beat by a constant interval of 0.24 second; such P waves were succeeded by phonocardiographic fourth heart sounds and were associated with the appearance of "C" waves and "E" points of greater magnitude on the apexcardiogram. Furthermore, each P wave was preceded by an elevated "O" point on the apex recording. Third heart sounds were present throughout the recording and first heart sounds were of greater amplitude when they were not preceded by fourth heart sounds (Fig 1).

DISCUSSION

The apexcardiogram described here demonstrates an unusual form of ventricular alternation based on the atrial contribution to ventricular filling. Some form of atrioventricular synchroniztion probably accounted for the constant P-R interval of the alternate beats. Atrial contractions consequent to P waves resulted in the alternate appearance of fourth heart sounds and atrial systolic waves, both

![Figure 1. Simultaneous tricuspid area phonocardiogram (TA) apexcardiogram (ACG), and lead II of the electrocardiogram (LII) recorded from a 65-year-old man. Note that each odd-numbered QRS complex (PA = pacing artifact) is preceded by a P wave, "x" wave, and fourth heart sound. Even-numbered QRS complexes are preceded by deeper "O" points and are associated with louder first heart sounds and lower "E" points. Third heart sounds are present throughout the tracing. (A. 1, 2, 3 = respective heart sounds, RFW = rapid filling wave, SFW = slow filling wave.)](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21546/)
representing the impact of blood upon the left ventricular wall. Increased left ventricular ejection with taller "E" points and lower "O" points. Thus, in this case, a pulse alternation at equal ventricular cycle lengths was not a result of poor ventricular function, but represented the mechanical atrial booster function. In conclusion, the apexcardiogram can aid in the noninvasive identification of unusual alterations of left ventricular function.

REFERENCES

ANNOUNCEMENTS

Postgraduate Course in Clinical Chest Diseases
The Mount Sinai School of Medicine of the City University of New York (Page and William Black Postgraduate School of Medicine) will present a Postgraduate Course on Clinical Chest Diseases, November 13-17. Course directors are: Drs. Louis E. Siltzbach, Robert S. Litvak, Irving J. Seikoff and Sidney M. Silverstone. The half-day sessions will be held at the Mount Sinai Medical Center, New York City; tuition is $75. For information, please write the Registrar, Page and William Black Postgraduate School of Medicine, Mount Sinai School of Medicine, 13th Course and 100th Street, New York City 10029.

Postgraduate Courses in Bronchoesophagology
Postgraduate Courses in Bronchoesophagology will be presented by Dr. Charles M. Norris and Gabriel F. Tucker, Jr., October 9-20, 1972 and February 5-16, 1973 at the Department of Laryngology and Bronchoesophagology, Temple University Hospital and School of Medicine, Philadelphia. For further information, please write: Chevalier Jackson Clinic, Temple University Hospital, 3401 North Broad Street, Philadelphia 19140.

Postgraduate Course: Clinical Management and Control of Tuberculosis
A postgraduate course in clinical management and control of tuberculosis, sponsored by the National Jewish Hospital, the University of Colorado Medical School, the Denver Health Department, Fitzsimons General Hospital, Colorado Tuberculosis and Respiratory Disease Association and the American Thoracic Society will be held at the National Jewish Hospital, Denver, November 6-17. Further information may be obtained from Dr. William Lester, Chief of Chest Medicine, National Jewish Hospital, Denver 80206.

Conference on Radiology in Otolaryngology and Ophthalmology
Dr. Galdino E. Valvasori will direct the Conference on Radiology in Otolaryngology and Ophthalmology November 24 and 25 at the Abraham Lincoln School of Medicine, Chicago. For information, please write Dr. Valvasori, Radiology Department, PO Box 6998, Chicago 60680.

Postgraduate Course in Laryngology and Bronchoesophagology
The Department of Otolaryngology, Abraham Lincoln School of Medicine and the University of Illinois Eye and Ear Infirmary, Chicago, will conduct a continuing education course in laryngology and bronchoesophagology November 13-18. The course is limited to 15 physicians and will be under the direction of Dr. Paul H. Holinger. Interested physicians should write the Department of Otolaryngology, University of Illinois at the Medical Center, PO Box 6998, Chicago 60680.