Praecordial pulsations in health and disease

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Summary

In a previous paper (Mounsey, 1966) the genesis of praecordial pulsations in health and disease was examined. The normal, short, outward impulse at the apex reflected underlying early systolic outward movement of the underlying ventricle as visualized in the lateral angiocardio-gram. The sustained impulse of left ventricular hypertrophy was seen in the angiocardio-gram to be due to failure of retraction of the antero-apical portion of the left ventricle in late systole. In cardiac aneurysm where a sustained impulse is also met, paradoxical pulsation of the aneurysm with failure of late systolic retraction accounted for the abnormal impulse.

Marked systolic retraction of the cardiac impulse was met in two important conditions, tricuspid incompetence and constrictive pericarditis. The high stroke-output of the dilated right ventricle in tricuspid incompetence with both forward and backward ejection of blood accounted for systolic retraction at the apex in this condition. In constrictive pericarditis, on the other hand, in cases where the process involves predominantly the atrioventricular groove and out-flow tract regions, the relatively free surface of the anterior wall of the right ventricle may show compensatory increased movement with marked systolic retraction and diastolic expansion, themselves in turn transmitted to the praecordium.

The giant atrial beat of hypertrophic obstructive cardiomyopathy reflected increased atrio-ventricular transport function as was shown in the timed cineangiocardio-gram.

In the present paper, details of the form of the cardiac impulse in health and disease are described. These have been recorded with an instrument measuring absolute displacement, the impulse cardiograph (Beilin & Mounsey, 1962). The impulse cardiogram aims at being a graphic record of what the physician's hand and fingers feel.

The form of the ventricular systolic impulse

In the same way that phonocardiography has

emphasized the importance of accurate timing of sounds and murmurs, so impulse cardiography has shown the diagnostic value of careful timing of the impulse. Too much importance should not be attached to the amplitude of the cardiac impulse. This may be exaggerated in the presence of a normal heart in thin and anxious subjects or be diminished with a hypertrophied heart in a fat placid patient with a barrel chest. Timing of the ventricular systolic impulse, however, is not affected by either the patient's build or his basal state, but is closely related to the presence of heart disease.

There are four main types of ventricular systolic impulse, each of which can be readily distinguished at the bedside (Mounsey, 1966). Timing of the impulse is achieved by listening with the stethoscope and simultaneously palpating and observing praecordial movements. The *normal cardiac impulse* is a relatively short outward movement, starting at the time of the first heart sound (Fig. 1a). Its peak is reached during the first third of systole, after which it falls inwards again, usually showing some retraction in late systole. A characteristic of the normal cardiac impulse is that it always returns to the baseline by the time of the second heart sound. The second type of ventricular systolic impulse is the *overacting impulse** which is one of normal form but of abnormally large amplitude (Fig. 1b). It is seen in any high-output state such as thyrotoxicosis, or in simple anxiety, but it is also related to the build of the chest, being common in children and also in adults with a depressed sternum. Another condition that gives rise to an overacting impulse at the left sternal edge is an atrial septal defect, where the output of the right ventricle is greatly increased from the left to right intra-atrial shunt. The third type of ventricular systolic impulse is the *sustained*

*Although the so-called 'tapping impulse' of mitral stenosis may sometimes have some features of an overacting impulse, the tapping quality arises more from palpable vibrations of the loud first heart sound than from displacement of the praecordium.

FIG. 1. (a) The apical impulse cardiogram (apex) in health. Pre-EB: pre-ejection beat. Phonocardiograms: PA, HF: pulmonary area, high frequency. LSE, LF: left sternal edge, low frequency. 1 and 2: first and second heart sounds. Electrocardiogram lead II. The ejection beat returns to the baseline before the last third of systole, when slight systolic retraction is seen in this subject. (The pre-ejection and ejection beats together compose the ventricular systolic impulse.)

(b) Apical impulse cardiogram (apex) of the overacting type, in thyrotoxicosis. Increased amplitude of ejection beat. Pre-EB: pre-ejection beat. Phonocardiogram: SA, LF: supramammary area, low frequency. AS: atrial sound, coinciding with the central portion of the atrial beat. SM: systolic murmur. Electrocardiogram lead II.

(c) Apical impulse cardiogram (apex) of the sustained type, in hypertensive heart disease. Outward ejection beat sustained up to time of second heart sound (2). Pre-EB: pre-ejection beat. Phonocardiogram: PA, HF: pulmonary area, high frequency. SA, LF: supramammary area, low frequency. AS: atrial sound coinciding with peak of outward movement of atrial beat.

FIG. 2. (a) Annular constrictive pericarditis as seen at operation. Pericardial constriction, (1) in A-V groove, and (2) around base of aorta and pulmonary artery.

(b) Impulse cardiogram in annular constrictive pericarditis. Marked systolic retraction at apex and lesser amount at left sternal edge. Systolic outward beat is present over the right chest. Steep diastolic rapid inflow beat at apex.

FIG. 3. Impulse cardiogram, chest X-ray, cineradiogram left cardiac border, and cross-section of heart at autopsy in patient with cardiac aneurysm. Paradoxical systolic pulsation shown in cineradiogram tracings, accounting for overlying sustained cardiac impulse. Bulging of left cardiac border in chest X-ray. Extensive infarct involving whole of lateral wall of left ventricle at autopsy. ECG showing ST elevation and tall T waves in anterior chest leads.

impulse (Fig. 1c). This is seen in the presence of hypertrophy of either ventricle, and also in cardiac aneurysm. The impulse starts at the time of the first heart sound as in health, but is sustained right up to and even beyond the time of the second heart sound. It is what is usually referred to as a 'heaving' or 'lifting' type of impulse, but is more aptly described by the French as the 'choc en dôme'. A sustained cardiac im-

pulse is never met in health if the subject is examined lying back, propped up at 45°. Its presence always indicates the presence of heart disease. The fourth type of cardiac impulse is the *retracting impulse*, in which marked, late systolic retraction occurs, followed by an equally

*Assumption of the left lateral decubitus position deforms the pattern of the impulse because of diaphragmatic and mediastinal shift (Boicourt, Nagle & Mounsey, 1965).

abnormal, outward movement in early diastole (Fig. 2). Accurate timing is necessary to analyse this impulse, for on superficial examination systole may be easily confused with diastole. This type of impulse is met in constrictive pericarditis, tricuspid incompetence, when it is localized to the apex, or with extensive pleuropericardial adhesions (Boicourt *et al.*, 1965).

The sustained ventricular systolic impulse is one of the most useful palpatory physical signs indicating heart disease. By far its commonest cause is hypertrophy of either left or right ventricle, when it is usually most marked at the apex and left parasternal areas respectively. When it is due to a cardiac aneurysm, the sustained cardiac impulse is of greatest amplitude in the praecordial area overlying the aneurysm, which is seen to show paradoxical pulsation on screening (Fig. 3) (Mourdjinis *et al.*, 1968). Careful palpation of the praecordium combined with detailed screening of the heart will reveal an often unsuspected ventricular aneurysm in as many as 15% of patients who have had a cardiac infarct.

Severe mitral incompetence may sometimes mimic right ventricular hypertrophy (Fig. 4). Here, left atrial systolic expansion gives rise to a sustained left parasternal impulse, even without associated right ventricular hypertrophy.

The use of the sustained and overacting type of impulse to differentiate between systolic and diastolic overload has proved helpful with lesions of the right heart, but less so with those affecting the left heart. In atrial septal defect the

relationship seems to hold, an overacting impulse being seen with a left-to-right shunt with little or no rise in pulmonary artery pressure, but a sustained impulse appearing with associated pulmonary hypertension (Fig. 5) (Gillam, Deliannis & Mounsey, 1964). In aortic or mitral incompetence, on the other hand, where diastolic overload is present, either an overacting impulse or a sustained impulse or a mixture of the two may be met (Fig. 6).

The atrial beat

Although Mackenzie (1908) drew attention to the atrial beat in the apex cardiogram, palpation of the atrial beat has only recently been accorded importance in clinical diagnosis. A small outward movement accompanying mechanical atrial systole is always recorded in the impulse cardiogram in health, but is rarely palpable. In the presence of ventricular hypertrophy, however, an augmented and palpable atrial beat is the rule. The hand appreciates this as an initial outward movement preceding the first heart sound and the ventricular systolic impulse. Looked at in the impulse cardiogram it may form a staircase effect, the first or smaller step being the atrial beat followed by the larger ventricular systolic beat (Fig. 1c). In others, it may form two distinct separate outward movements. Sometimes it is of such large amplitude as to be mistaken for the ventricular systolic beat, as in hypertrophic obstructive cardiomyopathy. Here, the atrial beat may dwarf the ventricular

FIG. 4. Sustained left parasternal impulse (LPI) with simultaneous late systolic retraction in apical impulse (apex) in patient with gross mitral incompetence and normal right heart pressures. Phonocardiogram: AA, MF: aortic area, medium frequency.

FIG. 5. Diagram of cardiograms of left parasternal impulse of atrial septal defect in relation to pulmonary systemic flow ratios and right ventricular pressures. Overacting impulses in five out of seven patients with little pulmonary hypertension (Cases 1, 2, 4, 5 and 7), with outward impulse virtually complete by first two-thirds systole (shaded area). Sustained impulse in pulmonary hypertensive patient (Case 8), with outward impulse continued into last third systole (shaded area).

systolic beat, a physical sign which at once suggests the possibility of this diagnosis (Fig. 7) (Nagle *et al.*, 1966). An atrial beat of increased amplitude is also often met in ischaemic heart disease and is especially large in the presence of ventricular aneurysm (Fig. 3). An augmented atrial beat is always accompanied by an atrial sound (Fig. 1). To the trained observer feeling the atrial beat is often easier than hearing the atrial sound.

FIG. 6. Apical impulse cardiogram (apex): mixed, sustained and overacting type in aortic incompetence. The diastolic rapid inflow beat (DRIB) is immediately followed by the atrial beat (AB), which are thus summated. The third heart sound (3) coincides with the peak of the diastolic rapid inflow beat. The atrial sound (AS) follows closely the peak of the atrial beat. Phonocardiogram: MA, LF: mitral area, low frequency. AA, HF: aortic area, high frequency. 1 and 2: first and second heart sounds. SM: systolic murmur. EDM: early diastolic murmur.

FIG. 7. Giant atrial beat (AB) in cardiomyopathy, exceeding in amplitude the ventricular systolic impulse. Phonocardiogram: LSE, MF: left sternal edge, medium frequency. ASM: atrial systolic murmur. 1 and 2: first and second heart sounds. SM: systolic murmur. Electrocardiogram lead II.

The diastolic rapid inflow beat

During the period of rapid ventricular filling and coincidental with the third heart sound, an outward movement is recorded in the impulse cardiogram, which we have named the diastolic rapid inflow beat. In contradistinction to the atrial sound it is usually easier to hear the third heart sound than to feel the diastolic rapid inflow beat, so that this palpatory physical sign is less common than the atrial beat. There are two conditions, however, in which the diastolic rapid inflow beat becomes easily recognizable clinically. These are constrictive pericarditis, when its steep upstroke is accompanied by an early diastolic sound (Fig. 2) (Mounsey, 1959), and in tricuspid and sometimes mitral incompetence. The force of the diastolic rapid inflow beat in these diseases is sometimes so great as to cause confusion with the ventricular systolic impulse.

Acknowledgment

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