MID-SYSTOLIC CLICKS

J. V. O. REID, B.M., M.R.C.P., *Department of Medicine,* University of Natal, and King Edward VIII Hospital, Durban*

The multiple aetiology of heart sounds that occur during systole has been recognized in recent years, and in particular a differentiation has been made between those of arterial or semilunar-valve origin (including the commonly encountered ejection clicks), those of atrial origin in atrioventricular dissociation, and those of extracardiac origin. It is with this last variety that the present paper is concerned.

Extracardiac systolic sounds are themselves of multiple aetiology, and their possible causes have been listed by Reid and Humphries.[1] In general, some of these sounds can be clearly recognized to depend on extracardiac features such as a left pneumothorax or mediastinal emphysema. However, a large group remains which was considered extracardiac by Gallavardin,[2] and subsequently by most authors[3-9] although no extracardiac cause was consistently found. The sound in this group was called the mid-systolic click by Wolferth and Margolies,[5] who reviewed the literature. Several series of cases have been recorded.[2,4,5]

CASE RECORDS

Eight patients have been seen in whom mid-systolic clicks were heard and recorded phonocardiographically, using a Sanborn 'twinbeam cardiette'. A simultaneous lead II tracing of the electrocardiogram was obtained, and in any case where there could be doubt regarding the identification of the second sound, an indirect carotid-artery tracing was made. In 3 cases the phonocardiogram showed that the click was followed by a murmur continuing to the second sound, the murmur being inconstantly present in 1 case. In 3 further patients the click was unaccompanied by a murmur; while in the remaining 2 cases the click occurred during a pansystolic murmur which, in some cycles, was exaggerated following the click. Details of the 8 cases are given in Table I, and the phonocardiograms are shown in Figs. 1 - 8.

In 7 cases the features of the mid-systolic click were similar to those described in the literature. It was heard best in the tricuspid area or just medial to the mitral area and was usually a single sound, but in 1 case it was clearly double (Fig. 7). The intensity varied slightly with respiration and according to whether the patient was lying, sitting or standing. Although the change with posture and respiration was constant for any one patient, there was no constancy from patient to patient, as was shown by Johnston.[4] The position of the sound in systole in these 7 cases was constant as judged clinically, but on the phonocardiogram it could be shown to vary by as much as 0·03 seconds in its relation to the second sound. This variation could clearly be shown in 4 cases to be an increase in the interval between click and second sound on inspiration. In the other 3 cases under consideration, the phonocardiographic interpretation was made difficult by the breath sounds. The relation to the first sound and to the R wave of the electrocardiogram was, in contrast, inconstant.

In the remaining patient (case 5, Fig. 5) the click varied rapidly, unpredictably and very considerably in its position in systole, being anywhere from very early to mid-systole, but never later than two-thirds of the interval between the first and second sounds. It occurred during a pansystolic murmur which in some cycles was accentuated following the click (Fig. 5, first cycle).

DISCUSSION

The reasons for considering the mid-systolic click to be extracardiac are: the demonstration of pleuropericardial adhesions in 3 cases by Gallavardin,[2] without any intracardiac cause being found; the variability of intensity with respiration and position of the patient;[4,7-9] the presumption that no valve movements take place during systole;[7,9] the variability from cycle to cycle of the time between the R wave of the electrocardiogram and the click;[4] and the character of the sound itself.

Several authors have recorded systolic murmurs that begin with this click. Minhas and Gasul[8] state that the click may or may not precede a systolic murmur, and they record one that began at a systolic murmur and one that occurred in the middle of a systolic murmur. McKusick *et al.*[6] illustrate 2 clicks which originated mid-systolic murmurs. Leatham[7] shows a phonocardiogram in which a loud systolic murmur extended from the click to the second sound; Johnston[4] describes a similar case. Bleifer *et al.*[9] show a phonocardiogram of one such case and state that 'not uncommonly, a systolic murmur originates with a (mid-systolic) click, and extends to the second sound and occasionally into diastole'.

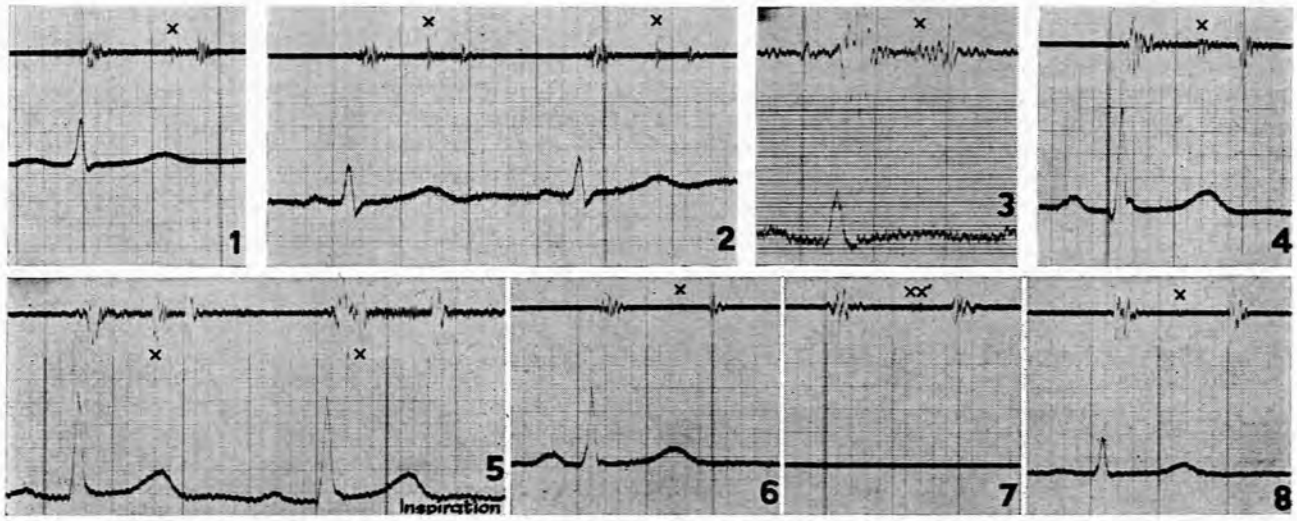
Association with a murmur provides reasonable evidence of an intravascular or intracardiac origin. Because the click is characteristically heard best just within the mitral area or in the tricuspid area, and because in 3 of the present cases a murmur began with the click and continued to the second sound (implying a ventriculo-atrial regurgitation), it seems that the click may be of atrioventricular valve origin in some cases. It does not seem illogical to assume that the valves can be competent at an early stage of systole and become incompetent later, since the design of the atrioventricular valves is unique: the apposition of the cusps is maintained *via* chordae by muscles which themselves are attached to the moving part of the pump, i.e. the ventricular muscle. The papillary muscles contract in systole and so apposition of the cusps is maintained. It is conceivable that a disturbance of this action, for example, by insufficient contraction of a papillary muscle, or by elongation of a chorda, may result in a slackening of the chorda in mid-systole. At this stage the high-pressure gradient across the valve might be expected to snap a slack chorda taut, producing a sound. The attached cusp might then still be competent, producing no murmur; or incompetent, with the production of a murmur that should extend to the second sound or into

* Now Department of Physiology.

TABLE I. FINDINGS IN 8 PATIENTS WITH MID-SYSTOLIC CLICKS

Case	*Race*	*Sex*	*Age*	*History*	*Findings*	*ECG*	*Chest radiograph*	*Comment*
1. S.K.	Indian	F	18	Incidental findings. No symptoms	MSC in MA followed by murmur	Normal	Normal	
2. Z.K.	Indian	F	25	Rheumatic fever, aged 10. Dyspnoea and palpitations for 2 years. On digitalis	Slight LV+. MSC in TA followed by murmur	Digitalis effect	Not done	
3. J.B.	European	F	49	Bone pains for 2 years	Classical myelomatosis. Uraemia. Apical and parasternal cardiac thrust. First sound accentuated. B.P. 120/70 mm. Hg. MSC in MA followed inconstantly by murmur	Normal	General cardiomegaly	Diagnosis of amyloid heart not proved
4. J.R.	Indian	M	19	Intermittent epigastric pain relieved by food, for 2 months	MSC in MA during a pansystolic murmur	Normal	Normal	Probable peptic ulcer
5. M.M.	African	F	12	Weakness of right hand	No neurological abnormality. Slight LV+. MSC in MA during a pansystolic murmur. No evidence of active rheumatic fever	Normal	LV+	
6. S.P.	Indian	M	15	Flitting polyarthralgia	Acute rheumatic arthritis. MSC in TA. No other clinical evidence of active carditis	Q-Tc 0.463 seconds	Normal	
7. V.P.	Indian	F	14	Flitting polyarthralgia	Acute rheumatic arthritis. MSC in TA. No other clinical evidence of active carditis	Not done	Normal	Patient seen 1 month before for iron-deficiency anaemia; had no MSC then
8. L.G.	Indian	F	30	Incidental finding. Slight dyspnoea on exertion; on close questioning, not considered significant	Depressed sternum. MSC in MA	Normal	Normal	

MSC = mid-systolic click, MA = mitral area, TA = tricuspid area, LV = left ventricle, + = enlargement.



Figs. 1-8. In all figures the phonocardiogram is shown as the upper tracing, lead II of the electrocardiogram as the lower tracing. Except in Fig. 3, logarithmic phonocardiograms are reproduced; in Fig. 3 the phonocardiogram is stethoscopic. The mid-systolic click is denoted by 'X' against the phonocardiogram and by MSC in the legends. Large divisions = 0·2 seconds, small divisions = 0·04 seconds.

Fig. 1. Case 1. MSC followed by vibrations continuing to the second sound.

Fig. 2. Case 2. MSC followed by a murmur and just preceded by a few vibrations.

Fig. 3. Case 3. MSC followed by a murmur continuing to the second sound.

Fig. 4. Case 4. MSC in the course of a pansystolic murmur.

Fig. 5. Case 5. MSC changing position in systole and occurring during a pansystolic murmur which appears accentuated following the MSC in the first cycle. Breath sounds partly account for the apparent loudness of the murmur in the second cycle, and entirely for the vibrations following the second sound of this cycle.

Fig. 6. Case 6. MSC unaccompanied by any murmur.

Fig. 7. Case 7. Double MSC unaccompanied by any murmur. The electrocardiogram was not recorded during this cycle, which was taken with the patient sitting, due to electrical interference.

Fig. 8. Case 8. Soft MSC unaccompanied by any murmur.

diastole as far as mitral or tricuspid re-opening, as is the case in ordinary mitral and tricuspid incompetence. In accordance with this explanation a mid-systolic click might be termed a 'chordal snap'.

Such a situation does not necessarily imply any visible pathological change in the valve, nor any significant resultant myocardial hypertrophy. However, it would be expected that pathological change in the chordae tendineae, papillary muscles, the valve cusp, or the ventricular muscle would predispose to the occurrence of a mid-systolic click, and be found especially in cases where there is a murmur. It will be observed that, in the 5 cases where systolic murmurs were present, cardiac abnormality was detected in 3. In the 3 cases without a murmur, cardiac abnormality was not detected in any, but was conceivably present in 2 (cases 6 and 7) where acute rheumatic arthritis was present.

No radiological evidence of pleural or pleuropericardial adhesions was found in the 7 patients examined, a finding similar to that of Johnston[4] who observed tenting of the diaphragm in only 1 of 15 cases.

SUMMARY

Mid-systolic clicks can be ascribed in some cases to definite causes such as a small pneumothorax; in many cases no cause is discoverable and the sound is presumed to arise from pleuropericardial adhesions.

In 8 patients mid-systolic clicks have been heard and recorded. In 3 the click was followed by a murmur that continued at least to the second sound, in 2 it occurred during a murmur that continued to the second sound. Similar cases of mid-systolic clicks initiating a murmur ending at the second sound have been described in the literature and have been ascribed similarly to pleuropericardial adhesions.

It is argued that a possible explanation of this mid-systolic click is a snapping taut of a chorda tendinea during the later high-pressure phase of ventricular systole which, when resulting in mitral incompetence, is followed by a murmur that continues, like the murmur of mitral incompetence, at least to the second sound. The term 'chordal snap' is proposed for mid-systolic clicks in which this explanation is thought operative.

I thank Dr. N. A. Rossiter for permission to study and include one patient, and Dr. S. Disler, Medical Superintendent of King Edward VIII Hospital, for facilities.

REFERENCES

1. Reid, J. A. and Humphries, J. O'N. (1955): Bull. Johns Hopk. Hosp., **97**, 177.
2. Gallavardin, L. (1913): Lyon méd., **121**, 409.
3. Lian, C. and Deparis, M. (1933): Bull. Soc. méd. Hôp. Paris, **49**, 496.
4. Johnston, F. D. (1938): Amer. Heart. J., **15**, 221.
5. Wolferth, C. C. and Margolies, A. (1940): *Ibid.*, **19**, 129.
6. McKusick, V. A., Kline, E. W. and Webb, G. N. (1955): *Ibid.*, **49**, 911.
7. Leatham, A. (1958): Lancet, **2**, 703.
8. Minhas, K. and Gasul, B. M. (1959): Amer. Heart J., **57**, 49.
9. Bleifer, S., Kahn, M., Grishman, A. and Donoso, E. (1959): Amer. J. Cardiol., **4**, 492.