Graphic Registration of Cardiac Thrills in Acquired and Congenital Heart Disease

By David C. Levinson, M.D., John P. Mehan, Jr., M.D., Leonard H. Schwartz, M.D., and George C. Griffith, M.D.

A method is described for the graphic registration of cardiac thrills. A thrill is defined as a chest wall vibration of sufficient intensity to be recognized by tactile sensation.

Cardiac thrills were picked up through a pulse capsule attachment and recorded on a Sanborn Twinbeam Cardiette. Simultaneously, heart sounds and murmurs were recorded on a second channel. The relative sensitivity of the 2 systems (stethoscopic microphone and amplifier, and pulse capsule pickup and amplifier) was determined by comparison with a calibrated audio signal. The pulse capsule attachment had its greatest sensitivity at 80 cycles per second, at which point it was 61 times as sensitive as the stethoscopic microphone. The pulse capsule attachment was relatively insensitive below 20 and above 120 c.p.s. The stethoscopic microphone was uniformly sensitive from 20 to above 250 c.p.s.

Thrills were recorded in a large number of patients with acquired and congenital heart disease, and were within the range of 60 to 100 c.p.s., with the greatest number falling in the range of 75 to 85 c.p.s.

This technic affords the clinician a new method of visually recording a palpable clinical finding. In addition to its value as a teaching aid, the record indicates the time and duration of the thrill in the cardiac cycle, and provides a permanent record of this physical finding.

The purposes of this report are to describe a method that has been used for the graphic registration of cardiac thrills and to present data concerning the frequencies of cardiac thrills in several clinical disorders. By definition, a thrill is a vibration of the chest wall of sufficient intensity to be recognized by tactile sensation. These vibrations are usually produced by rapid blood flow through a narrowed orifice into a larger chamber or vessel. Although thrills can be recognized over a large range of frequencies, vibrations in the lower frequency range are most readily appreciated. Partly for this reason, palpable thrills are all of fairly low frequency. For these reasons, a method for recording the low-frequency vibrations of the chest wall was developed, based on the use of a pulse capsule attachment.* As will be shown later, this method of recording the vibrations of the chest wall gives some frequency discrimination in that frequencies much over 100 c.p.s. are fairly well rejected by this recording system.

Methods and Equipment

A Sanborn Twinbeam Model no. 62 Cardiette was used to obtain simultaneous records of heart sounds and cardiac thrills. In the upper channel, the cardiac sounds were recorded with the conventional stethoscopic microphone and heart sound amplifier. In the lower channel, records of the low-frequency vibrations of the chest wall were obtained. This included the thrill, heart sounds, and slow movements of the chest wall such as ventricular lifts. In brief, the latter pulse capsule attachment produced a record somewhat similar to an apex cardiogram, but in addition registered cardiac thrills.

The relative sensitivity of the 2 recording systems was determined by comparing their performance with a calibrated audio signal. The standardized audio signal was obtained by amplifying the output of a Hewlett-Packard type 140A oscillator to drive a specially constructed speaker unit. The microphone and pulse capsule attachment were similarly oriented in front of the speaker.*

* Pulse capsule attachment provided for use with a Sanborn Model No. 2 Cardiette.

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Outputs of both systems were measured as the amplitudes of the respective galvanometer traces of the Sanborn twinbeam recorder. The audio output from the speaker was examined by means of a linear microphone and cathode-ray oscilloscope. The experimental data from both systems under test were corrected for the nonlinear characteristics of the speaker used in the calibration studies. The relative sensitivities of the 2 systems at different frequencies are shown in figure 1. At 70 c.p.s. the pulse capsule attachment was about 4 times as sensitive as the stethoscopic microphone and at 80 c.p.s. it was approximately 6 1/4 times as sensitive.

**RESULTS**

Simultaneous records of the heart sounds and thrills were obtained in 75 patients with acquired and congenital heart disease and palpable thrills. The following 10 representative cases are presented. The diagnosis was made in all instances after extensive clinical and laboratory study with confirmation by cardiac catheterization in most instances.

**Acquired Heart Disease**

**Case 1: “Pure” Mitral Stenosis (fig. 2).** Heart sounds and thrill were recorded simultaneously from the mitral area. The frequency of the diastolic thrill was 85 c.p.s. The murmur was maximum in middiastole, whereas the thrill persisted throughout diastole.

**Case 2: “Pure” Mitral Insufficiency (fig. 3).** Heart sounds and thrill were recorded simultaneously at the mitral area. The systolic thrill had a frequency of 75 c.p.s., was pansystolic, and was of uniform intensity. The murmur was also pansystolic but had a complex wave form containing components of both high and low frequency.

**Case 3: “Pure” Aortic Stenosis (fig. 4).** Heart sounds and thrill were recorded simultaneously at the primary aortic area. The frequency of the systolic thrill was 65 c.p.s. Both thrill and murmur were of maximum intensity in midsystole.

**Case 4: Aortic Insufficiency and Stenosis, Probable Evagination of Aortic Valve Cusp (fig. 5).** Heart sounds and thrill were recorded simultaneously at the secondary aortic area. The frequency of the diastolic thrill was 100 c.p.s., and the murmur at its maximum ampli-

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**Fig. 1.** Relative sensitivity (ordinate) of the 2 recording systems: stethoscopic microphone with heart sound amplifier and pulse capsule pickup with general purpose amplifier. Abscissa, cycles per second.

**Fig. 2.** Heart sounds and thrill in “pure” mitral stenosis. **S1**—first heart sound; **S2**—second heart sound; **S3**—third heart sound; **OS**—opening snap of mitral valve; **ST**—systolic thrill; **DT**—diastolic thrill; **A**—closure of aortic valves; **P**—closure of pulmonic valves. (The same abbreviations are used in all subsequent records.)
tude was 150 c.p.s. The thrill was of uniform intensity and pandiastolic in duration, whereas the murmur was loudest in early diastole.

Case 5: Tricuspid Insufficiency (fig. 6). Heart sounds and thrill were recorded at the tricuspid area. The frequency of the systolic thrill was 85 c.p.s. Both thrill and murmur were pansystolic in duration.

Congenital Heart Disease

Case 6: Atrial Septal Defect (fig. 7). Heart sounds and thrills were recorded at the pulmonic area. The frequency of the systolic thrill was 75 c.p.s. Both thrill and murmur were pansystolic in duration.

Case 7: Interventricular Septal Defect (fig. 8).
Heart sounds and thrill were recorded at the secondary aortic area. The frequency of the systolic thrill was 90 c.p.s. Both thrill and murmur were pansystolic. The thrill reached its peak intensity in midsystole.

Case 8: Patent Ductus Arteriosus with Pulmonary Hypertension and Reversal of Shunt (fig. 9). Heart sounds and thrill were recorded at the pulmonic area. The frequency of the diastolic thrill was 75 c.p.s. Both thrill and murmur were pandiastolic in duration.

Case 9: Pulmonic Valvular Stenosis (fig. 10).
Heart sounds and thrill were recorded at the pulmonic area. The frequency of the systolic thrill was 70 c.p.s. Both thrill and murmur were pansystolic. The murmur was loudest in early systole whereas the thrill appeared more uniform throughout systole.

**Case 10: Truncus Arteriosus (fig. 11).** Heart sounds and thrill were recorded at the primary aortic area. The frequency of the systolic thrill was 85 c.p.s. Both murmur and thrill were pansystolic.

In the 10 cases most of the thrills were in the range of 60 to 100 c.p.s., with the greatest number falling in the range of 75 to 85 c.p.s.

Vibrations of the chest wall that can be recorded have a wide frequency range. Lui-
TABLE 1. Precordial Vibrations

<table>
<thead>
<tr>
<th>Phenomenon</th>
<th>Frequency range of vibrations (c.p.s.)</th>
<th>Physical method</th>
</tr>
</thead>
<tbody>
<tr>
<td>General movements of chest wall</td>
<td>0-5</td>
<td>Palpation</td>
</tr>
<tr>
<td>Diastolic sound (third and fourth heart sounds)</td>
<td>5-50</td>
<td>Palpation and auscultation</td>
</tr>
<tr>
<td>First and second heart sounds</td>
<td>10-100</td>
<td>Auscultation and palpation</td>
</tr>
<tr>
<td>Valvular snap, diastolic rumble at apex</td>
<td>10-150</td>
<td>Auscultation and palpation</td>
</tr>
<tr>
<td>Systolic murmurs, distolic basal murmurs</td>
<td>150-1000</td>
<td>Auscultation</td>
</tr>
</tbody>
</table>

sada\(^2\) has tabulated the type and range of these vibrations and classified them according to the nature of the vibrations and as to whether they are best recognized by palpation or auscultation (table 1).

The palpable vibrations heretofore described are listed in the table as being in the range of 0 to 150 c.p.s. These vibrations consist of slow movements of the chest wall, heart sounds, and the diastolic rumble of mitral stenosis. If the diastolic rumble of mitral stenosis is eliminated, these palpable vibrations range from 0 to 100 c.p.s. Also, heart sounds at times may be detected by both auscultation and palpation. Finally, it is to be noted that systolic murmurs and diastolic basal murmurs have a frequency range beginning at 150 c.p.s. and ranging upward to 1000 c.p.s.

The pulse capsule attachment used to record cardiac thrills was found to have its greatest sensitivity at 80 c.p.s. The range of most cardiac thrills that were recorded was between 75 and 85 c.p.s. Vibrations of this frequency are palpable if they are of sufficient intensity and duration.

The ability to record a thrill permits the clinician to confirm and have a permanent record of this physical finding. The record indicates the timing of the thrill within the cardiac cycle as well as its absolute duration. With this technic, a new teaching aid is added to the armamentarium of the clinician.

**SUMMARY**

A technic for the graphic registration of cardiac thrills and other low frequency vibrations of the chest wall has been described. Palpable cardiac thrills were noted to have a frequency range between 60 to 100 c.p.s., with the greatest number in the range of 75 to 85 c.p.s.

**SUMMARY IN INTERLINGUA**

Es describite un technica pro le registrazione graphic de fremitos cardiac e de aliter vibrationes a basse frequentias in le pariete thoracie. Esseva notate que palpable fremitos cardiac ha un scala de frequentias de inter 60 e 100 cyclos per secunda. Le plus grande numero de illos occurre con frequentias de inter 75 e 85 cyclos per secunda.

**REFERENCES**


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*Sit down before fact as a little child, be prepared to give up every preconceived notion, follow humbly wherever and to whatever abysses Nature leads, or you shall learn nothing. I have only begun to learn content and peace of mind since I have resolved at all risks to do this.—Huxley.*
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