Some Auscultatory and Phonocardiographic Features of Tricuspid Stenosis

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DESPITE considerable progress in the clinical diagnosis of rheumatic tricuspid stenosis, the lesion remains infrequently recognized. Its reported incidence among cases of multivalvular heart disease diagnosed during life is in the region of 2 to 3 per cent,\\(^1,2)\\) whereas it is more frequently (10 to 23 per cent) detected at autopsy\\(^3-6)\\) or surgical exploration.\\(^7)\\) Clinical recognition of tricuspid stenosis, even in mild form, is important for several reasons: its features may mimic right heart failure and may mislead the clinician in the assessment of the severity of coexisting valvular disease;\\(^1)\\) as a result of its presence, patients may fail to improve after successful mitral\\(^7,8)\\) or aortic\\(^9)\\) valvotomy; aortic or pulmonary insufficiency may be diagnosed incorrectly because of the diastolic murmur of tricuspid stenosis; a strong clinical suspicion of the diagnosis will prompt the use of a double-lumen cardiac catheter to record simultaneous right atrial and ventricular pressures, since a significant diastolic pressure gradient may be missed on simple withdrawal of an ordinary catheter across the tricuspid valve.\\(^10)\\)

The purpose of this report is to present the auscultatory and phonocardiographic features in nine cases of tricuspid stenosis with special reference to some features inadequately emphasized in the literature. Appreciation of these features resulted in an increased awareness of the condition, six of the cases being thereby correctly diagnosed within the past year.

Patients

The age, sex, and accompanying valve lesions of the nine patients are shown in table 1. Tricuspid stenosis was confirmed by cardiac catheterization in all and during tricuspid valvotomy in cases 3 and 4. In five patients tricuspid insufficiency was also present.

Hemodynamic Findings (Table 1)

In three patients, the mean diastolic pressure gradient across the tricuspid valve, determined by simultaneous recording of right atrial and ventricular pressures, was 3, 4, and 5 mm Hg, respectively, and increased further on exercise. These values are indicative of stenosis by current criteria.\\(^11)\\) Two patients in sinus rhythm (cases 1 and 2) had substantial presystolic pressure gradients and in the remaining four patients, who were in atrial fibrillation, the lowest diastolic pressure in the right atrium was at least 2 mm Hg higher than the right ventricular end-diastolic pressure.

Symptoms and Signs

The symptoms and signs in these patients conform to those described in the literature\\(^1,2,10,12-14)\\) and, with the exception of a prominent "a" wave in the jugular venous pulse, were not of particular aid in diagnosis. A slow "y" descent in the venous pulse,\\(^1,10)\\) although specifically sought, was not detected in any patient, probably due to the small pressure gradients; the presence of this sign has probably been overemphasized.

Auscultatory and Phonocardiographic Findings

Tricuspid Mid-diastolic Murmurs (Figs. 1-3)

These were clearly heard and recorded in the six patients in atrial fibrillation. They were not noted in the three with sinus rhythm, as was also observed by Perloff and Harvey;\\(^10)\\) in each one of our patients, however, an early diastolic murmur may have obscured it. They were of low-to-moderate intensity and fairly well localized to the fourth and fifth left inter-

\* Cambridge phonocardiographic equipment.

From the Joint Cardiorespiratory Service of the Royal Victoria Hospital and the Montreal Children's Hospital, McGill University, Montreal, Canada.
Table 1

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Age</th>
<th>Sex</th>
<th>Diagnosis</th>
<th>RAP (a/v/y/m) mm. Hg</th>
<th>RVP (s/d) mm. Hg</th>
<th>Gradient mm. Hg</th>
<th>PWPm or LAPm mm. Hg</th>
<th>Cardiac index L./min./m.²</th>
<th>Rhythm</th>
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<tbody>
<tr>
<td>1.</td>
<td>29</td>
<td>F</td>
<td>MS(MI) TS(AI)</td>
<td>15/8/6/9</td>
<td>115/3</td>
<td>10*</td>
<td>37</td>
<td>2.4</td>
<td>Sinus (PR = 0.19)</td>
</tr>
<tr>
<td>2.</td>
<td>33</td>
<td>F</td>
<td>AS(AI)(MS) TS(TI)</td>
<td>10/6/4/6</td>
<td>20/2</td>
<td>8*</td>
<td>—</td>
<td>—</td>
<td>Sinus (PR = 0.16)</td>
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<tr>
<td>3.</td>
<td>49</td>
<td>F</td>
<td>MS(MI) TS</td>
<td>12/5/3/6</td>
<td>28/0</td>
<td>5† (rest)</td>
<td>12†</td>
<td>2.3</td>
<td>Sinus (PR = 0.30)</td>
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<tr>
<td>4.</td>
<td>38</td>
<td>F</td>
<td>MS-TS</td>
<td>—/8/3/6</td>
<td>46/0</td>
<td>4† (rest)</td>
<td>—</td>
<td>—</td>
<td>AF</td>
</tr>
<tr>
<td>5.</td>
<td>48</td>
<td>F</td>
<td>(MS-MI) TI(TS)</td>
<td>—/42/15/22</td>
<td>58/12</td>
<td>3† (rest)</td>
<td>—</td>
<td>—</td>
<td>AF</td>
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<tr>
<td>6.</td>
<td>48</td>
<td>F</td>
<td>MI(MS) TS-TI (AI)</td>
<td>—/15/7/10</td>
<td>55/5</td>
<td>&gt;2†</td>
<td>—</td>
<td>—</td>
<td>AF</td>
</tr>
<tr>
<td>7.</td>
<td>32</td>
<td>M</td>
<td>MS(MI) TS(TI)</td>
<td>—/10/9/8</td>
<td>90/5</td>
<td>&gt;2† see text</td>
<td>38</td>
<td>2.8</td>
<td>AF</td>
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<tr>
<td>8.</td>
<td>46</td>
<td>F</td>
<td>(MS) TS(TI)</td>
<td>—/12/8/10</td>
<td>25/6</td>
<td>&gt;2†</td>
<td>—</td>
<td>7.5†</td>
<td>AF</td>
</tr>
<tr>
<td>9.</td>
<td>34</td>
<td>F</td>
<td>MI(MS) TI-TS</td>
<td>—/11/8/9</td>
<td>40/5</td>
<td>&gt;2†</td>
<td>—</td>
<td>16</td>
<td>AF</td>
</tr>
</tbody>
</table>

* Presystolic gradient.
† Mean diastolic gradient.
‡ Mitral valvotomy, 2 to 6 years previously.

Abbreviations: RAP, right atrial pressure; a/v/y/m, pressure at "a," "v," "y," and mean atrial pressure; RVP, right ventricular pressure; s/d, systolic/end-diastolic; PWPm, pulmonary wedged pressure (mean); LAPm, left atrial pressure (mean); AF, atrial fibrillation; MS, mitral stenosis; TS, tricuspid stenosis; AS, aortic stenosis; MI, mitral insufficiency; TI, tricuspid insufficiency; AI, aortic insufficiency; PI, pulmonary insufficiency.

Lesions shown without parentheses were the dominant ones.

costal spaces by the sternal edge or between the sternal border and the apex; in one patient the murmur was louder and was propagated toward the apex and base (fig. 1). They commenced 0.05 to 0.08 second after A₂, were of short (fig. 2) or moderate length, and with one possible exception were louder on inspiration. In case 9, in whom a tricuspid and a mitral mid-diastolic murmur were both clearly recorded, the tricuspid had an earlier onset (fig. 2).

The most characteristic feature of the murmur was its pitch, which was higher than that of mitral mid-diastolic murmurs. In three cases it sounded scratchy and somewhat superficial and in one it was musical. Although not so high pitched and smooth, the tricuspid mid-diastolic murmur had been previously mistaken for an early diastolic in four of the six patients.

**Tricuspid Presystolic Murmurs**

These were best heard between the left sternal border and the apex and merged with the presystolic murmurs of the coexisting mitral stenosis. Thus, distinction between the two by stepwise auscultation was difficult. There was no appreciable difference in pitch between the two. The murmur at the tricuspid area always increased on inspiration, but attenuation of the mitral presystolic murmurs could be detected only in the sound records (fig. 4). In phonocardiograms these two mur-
Figure 1
Case 8. High-frequency, loud tricuspid mid-diastolic murmur (T-DM) increasing on inspiration and recorded at both tricuspid and pulmonary areas. Short systolic murmur (T-SM), best recorded at the tricuspid area, is possibly that of tricuspid insufficiency, as there was clinical and hemodynamic evidence of this lesion and not of aortic stenosis or pulmonary hypertension. Paper speed 50 mm./per second. In all figures: PA, pulmonary area; TA, tricuspid area; MA, mitral area; MF, medium frequency; 2, second sound; OS, opening snap; 3, third heart sound.

Opening Snap of the Tricuspid Valve

An opening snap was recorded in five patients and was tentatively considered of tricuspid origin in two, as it became louder on inspiration (fig. 3). The most reliable criterion of a tricuspid snap, however, i.e., the recording of a separate later mitral opening snap, was not fulfilled in any of the patients.

Discussion

The accentuation of the diastolic murmur of tricuspid stenosis on inspiration has been given rightful prominence as an important sign. It is less well known that Rivero-Carvallo also wrote that the murmur of tricuspid...
TRICUSPID STENOSIS

stenosis does not have the auscultatory characters of a rumble and added: "We think that many tricuspid murmurs are interpreted as being propagated from the aortic orifice." A high-frequency range of the diastolic murmurs of tricuspid stenosis was observed in spectral phonocardiograms by McKusick but he did not consider them high pitched on auscultation. Other workers described the murmurs of tricuspid stenosis as high pitched without stressing the importance of this feature or mentioning the possibility of their confusion with early diastolic murmurs.

On the basis of the findings in the present study the high pitch of the mid-diastolic murmur is considered to be the most suggestive single auscultatory feature of tricuspid stenosis. Therefore, confusion with the typical low-pitched murmur of mitral stenosis should not frequently arise. The high pitch and the similar site of optimal audibility may lead to confusion of tricuspid with early diastolic murmurs, as an observer may well fail to note the delayed onset of a murmur with a pitch and quality unlike that of common mitral diastolic murmurs. More similar to a tricuspid mid-diastolic murmur is the murmur of pulmonary regurgitation not associated with pulmonary hypertension. This murmur should be distinguished by the sharp localization at the pulmonary area and by the history, since

![Figure 2](image-url)

**Figure 2**

Case 9. Short, high-pitched, tricuspid mid-diastolic murmur (T-DM) commencing with an opening snap before the mitral mid-diastolic murmur (M-DM) onset of which coincides with the third sound. The second sound (A₂ and P₂) is split on expiration. The opening snap, mitral diastolic, and pansystolic (due to mitral insufficiency) murmurs are fainter on inspiration, whereas the tricuspid diastolic murmur is louder. (The mitral diastolic murmur in this case is compatible with that of pure mitral insufficiency. Left heart catheterization, however, indicated the presence of some obstruction to forward flow.) In figures 2 to 5 the paper speed was 100 mm. per second.
it is either secondary to pulmonary valvotomy or due to congenital pulmonary insufficiency.

The distinction between the tricuspid and mitral presystolic murmur was clearly made only by the phonocardiographic demonstration of a phase difference between the two. This important feature was also observed independently in case 3 by Gubbay. The difference in timing of the two murmurs was presumably due to the earlier onset of right atrial systole, which is an established hemodynamic sequence. This adequately explains the presence of a decrescendo phase in the tricuspid presystolic murmur, which was previously ascribed to the prolonged P-R interval that occurs in a high percentage of patients with tricuspid stenosis. As prolonged P-R interval may result in a diminuendo configuration of even a mitral presystolic murmur (fig. 4), only with a normal P-R in-

Figure 3

Case 6. High-frequency tricuspid mid-diastolic murmur (T-DM), and opening snap both louder on inspiration.
Figure 4

Case 3. Tricuspid (T-ASM) and mitral (M-ASM) atriosystolic (presystolic) murmur both possessing a decrescendo phase as a result of a prolonged P-R interval (0.3 second). Definite accentuation of the tricuspid murmur on inspiration accompanied by attenuation of the mitral. The earlier onset and peak of the tricuspid murmur, difficult to appreciate clinically, are obvious in this tracing. Giant “a” wave in the jugular venous tracing (JVP). EDM, aortic early diastolic murmur.

terval is a crescendo-diminuendo presystolic murmur indicative of tricuspid stenosis. The observation of separation of this tricuspid murmur from the first sound in the presence of a normal P-R interval has also been made by McKusick.16

During ordinary respiration, accentuation of the tricuspid diastolic murmur with inspiration was less, or not at all, apparent in one patient with a slow heart rate, as the changes in intensity did not always coincide with the peaks but rather with the transition between inspiration and expiration. Variability of cycle lengths with atrial fibrillation or sinus arrhythmia may also balance or even reverse changes of intensity occurring during continuous respiration.10 Auscultation in post-inspiratory apnea can also lead to error as the subjects tend to perform a Valsalva maneuver, which produces rapid attenuation of tricuspid murmurs.22 These comments are not intended to question the value of the inspiratory maneuver but, rather, to point out its limitations.

Summary and Conclusions

The auscultatory and phonocardiographic features in nine patients with tricuspid stenosis are described. In the presence of atrial fibrillation, there is a mid-diastolic murmur at the low left sternal area; this is of higher pitch than a mitral diastolic and is easily mistaken for an early diastolic murmur. With sinus rhythm, there is a presystolic murmur, which can be differentiated from the coexisting mitral murmur chiefly by its earlier onset, crescendo, and termination, demonstrable in the phonocardiogram. Both tricuspid mur-
murs increase on inspiration but there may be exceptions. As the remainder of the symptoms and physical signs, except for the “a” wave, do not assist in diagnosis, the auscultatory and phonocardiographic features are of paramount importance for the clinical suspicion of tricuspid stenosis. This will lead to the use of a double-lumen catheter for the hemodynamic confirmation of the diagnosis, as it may not be obtained without simultaneous determination of right atrial and ventricular pressures.

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References

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The Size of the Liver and Engorged Neck Veins

If it is beyond question that the veins of the neck are bilaterally congested and it is equally beyond doubt that the liver is not enlarged, an obstruction of the superior cava must be considered. Its diagnosis will rest upon the discovery of anastomotic veins and upon failure to induce the veins of the neck to pulsate. A second reason for the same discrepancy is atrophic cirrhosis of the liver in a congested patient; the diagnosis of the liver condition will then turn upon the degree of hardness, and perhaps irregularity, of the liver margin.

There is the reverse case: an engorgement of the liver has been present for a long time and the venous spaces within have become permanently dilated and its substance a little or much fibrosed. In such, even if the signs of increased pressure in the veins greatly decline, the size of the liver may not decrease much or proportionately. It is a discrepancy which previous knowledge of the course of the malady explains.—Sir Thomas Lewis, Diseases of the Heart. New York, The Macmillan Company, 1933, p. 16.
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