rotameter flow meter and a pressure transducer. The position of the indicator was read in millimeters distance from zero point, correlated to transducer readings in the spring housing. The results of these measurements, illustrated in Figure 3, describe instruments to flow rates exceeding one half of the ranges create pressures in the spring housing ranging from 4 to 20 cm H₂O.

**Figure 3.** Pressure flow curves obtained with above setup.

Methods have been performed with the use of a variable flow source, Venturi tube which has been precalibrated with a rotameter flow meter and a pressure transducer sensing the pressure in the spring housing. The results of these measurements, illustrated in Figure 3, describe instrument resistance to flow at all ranges.

The calibration procedure utilized the same setup. Short flow bursts exceeding one half second at different intensities were applied. The position of the indicator was read in millimeters distance from zero point, correlated to transducer readings and converted to liters flow. This procedure was repeated in all flow ranges. As can be noted, peak flows in all ranges create pressures in the spring housing ranging from 4 to 20 cm H₂O.

**Field Studies**

Preliminary field studies have been performed at the pulmonary function laboratory of the Beilinson Hospital Medical Center. One hundred subjects with normal and impaired lung function were selected. Their ages ranged from 5 to 60 years. Each subject performed five FFR measurements on the Wright peak flow meter and five measurements on the new instrument. The order of measurements was randomly selected. The three best readings of each instrument were selected for comparison and statistical analysis.

**Results**

The results of the measurements made on both instruments are shown in Table 1.

As can be seen, the mean values of FFR readings on both instruments as well as the standard deviation of the different groups of subjects are similar. The number of patients who fell into range 1 was small and could not be statistically evaluated. Therefore, results of range 1 were not included.

The differences of the readings, tested by the "T"

Table 1—Comparison of FFR Measurements on the Instrument and Wright Peak Flow Meter.

<table>
<thead>
<tr>
<th>Instrument*</th>
<th>Wright**</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>z ± SD</td>
</tr>
<tr>
<td>Range 2</td>
<td>21 271.7</td>
</tr>
<tr>
<td>Range 3</td>
<td>35 445.4</td>
</tr>
<tr>
<td>Range 4</td>
<td>44 588.9</td>
</tr>
</tbody>
</table>

*Instrument—The new expiratory peak flow meter
**Wright—Wright peak flow meter.

**Discussion**

The instrument described in this preliminary report was designed for the measurement of expiratory PFR which is an important parameter of mechanics of breathing. It has several important features which make it a useful instrument for this purpose: small size, light weight, simplicity, reliability and low cost. It is readily taken apart and assembled, easily cleaned and sterilized. Furthermore, its readings are reproducible and accurate. The comparative results of this instrument and Wright peak flow meter measurements demonstrate similar deviation and percentage of error.

It can be matched in performance with the standard equipment available now for clinical use and it fulfills therefore the demands made upon it by the clinician.

**Acknowledgment:** Technical advice was given and experimentations performed by the author at the pulmonary function laboratory, Beilinson Hospital Medical Center, Petah-Tikva, Israel.

**References**


**Sinus Rhythm with Ineffective Left Atrial Contraction in Severe Mitral Stenosis**

Amadeo Betriu, M.D.; Gines Sanz, M.D.; Allan G. Adelman, M.D.; and E. Douglas Wigle, M.D.

The present report documents the absence of left atrial "a" waves in two patients with sinus rhythm and longstanding mitral stenosis. In both cases, clearly identified right atrial "a" waves were recorded. Left atrial pressure tracings were obtained by transseptal heart catheterization. Ineffective left atrial contraction due to electromechanical dissociation provided a satisfactory explanation for this phenomenon.

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Sinus rhythm is generally associated with active atrial contraction. When the atrial contribution to ventricular filling is absent, a decrease in cardiac output of as much as 40 percent has been noted with rapid ventricular rates. However, sinus rhythm does not necessarily imply effective atrial transport. Bramwell and Jones noted small or diminutive “a” waves, which were thought to be due to poor atrial contraction, in patients with long standing severe mitral stenosis. They advanced the concept of “atrial failure” to characterize this situation. This paper describes two patients with mitral valve disease in whom the left atrial pressure tracings failed to show any evidence of “a” waves and in whom there was no evidence of atrial contraction despite the fact that they were in sinus rhythm.

**Case Reports**

**Case 1**

The patient was a woman who had no history of rheumatic fever and was well until age 42 when she developed increasing shortness of breath and decreasing exercise tolerance. At age 45 she underwent a mitral commissurotomy with an excellent result. At age 60, she was readmitted with a one-year history of recurrent respiratory tract infections and exertional dyspnea. Physical examination was consistent with moderately severe mitral stenosis, mild mitral insufficiency and secondary pulmonary hypertension. The electrocardiogram (Fig 1) showed sinus rhythm, a slightly prolonged PR interval with unexpected small P waves and nonspecific ST-T changes. Calcification of the left atrial wall was demonstrated radiographically. The results of heart catheterization, summarized in Table 1, confirmed the clinical diagnosis. Although prominent “c” and “v” waves were seen in the left atrial pressure tracing obtained by transeptal left heart catheterization, no “a” wave was recorded despite the fact that the patient was in sinus rhythm and an “a” wave was present in the right atrial pressure tracing (Fig 2).

**Case 2**

A 40-year old man with no antecedent history of rheumatic fever developed atrial fibrillation and congestive heart failure secondary to mitral stenosis. A mitral commissurotomy was performed and he remained asymptomatic for ten years following surgery. At the age of 52, he was readmitted with a two-year history of progressively increasing shortness of

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Table 1—Hemodynamics in Two Patients in Sinus Rhythm with Ineffective Left Atrial Contraction

<table>
<thead>
<tr>
<th>Rhythm</th>
<th>LA</th>
<th>PA</th>
<th>CI</th>
<th>PVR</th>
<th>MDG</th>
<th>Area</th>
<th>M Re-gurg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>mm</td>
<td>L/min</td>
<td>dy</td>
<td>mm/3</td>
<td>cm-3</td>
<td>Hg</td>
</tr>
<tr>
<td>Case 1</td>
<td>Sinus</td>
<td>26</td>
<td>50</td>
<td>2.43</td>
<td>482</td>
<td>11.4</td>
<td>1.28</td>
</tr>
<tr>
<td>Case 2</td>
<td>Sinus</td>
<td>30</td>
<td>48</td>
<td>1.86</td>
<td>400</td>
<td>12.7</td>
<td>.97</td>
</tr>
</tbody>
</table>

LA Left Atrium
PA Pulmonary Artery
CI Cardiac Index
PVR Pulmonary Vascular Resistance
MDG Mean Diastolic Gradient
M Area Mitral Area
M Regurg Mitral Regurgitation

FIGURE 1. Electrocardiogram of case 1 showing sinus rhythm and borderline PR interval (.20 sec). The main vector of atrial depolarization is perpendicular to frontal plane and, consequently, P waves are not well identified in peripheral leads. Note their small voltage and amplitude.

FIGURE 2. Simultaneous left ventricular (LV) and left atrial (LA) pressures (top) demonstrating the absence of “a” waves in case 1. Right atrial (RA) pressure tracing (bottom) demonstrates the presence of well defined right atrial “a” waves.
block and left atrial enlargement (Fig 3). Cardiac catheterization with secondary pulmonary hypertension and a breath. Two months prior to admission he reverted spontaneously from atrial fibrillation to sinus rhythm. Physical findings were in keeping with pure severe mitral stenosis and the electrocardiogram showed sinus rhythm, first degree A-V block and left atrial enlargement (Fig 3). Cardiac catheterization (Table 1) confirmed the presence of severe mitral stenosis with secondary pulmonary hypertension and a low cardiac output. The left atrial pressure recording obtained by transseptal left heart catheterization did not demonstrate "a" waves, whereas "a" waves were evident in the right atrial pressure tracing (Fig 4).

![Figure 3. Twelve lead electrocardiogram showing sinus rhythm, first degree AV block, left atrial enlargement and, possibly, biventricular hypertrophy in case 2.](image)

![Figure 4. Simultaneous left ventricular (LV) and left atrial (LA) pressure tracings (top) in case 2. No "a" waves are recognized despite presence of sinus rhythm. Waves are clearly identified in right atrial tracing (bottom).](image)

**Discussion**

The absence of "a" waves in the left atrial pressure tracing in these two cases demonstrates that despite the presence of sinus rhythm, patients with longstanding mitral stenosis may have ineffective left atrial contraction. This could be due to unilateral left atrial fibrillation, an interatrial conduction disturbance (interatrial block, either complete or incomplete), absence of left atrial depolarization or electro-mechanical dissociation.

Unilateral atrial fibrillation is an extremely uncommon arrhythmia and in this condition fibrillatory waves, which are not evident in these two patients, should be seen on the electrocardiogram. If incomplete interatrial block were present, the left atrial component of the P wave would be delayed and possibly buried in the QRS complex, but one would still expect to find evidence of left atrial contraction (ie, "a" waves) in the left atrial pressure tracings. Complete interatrial block, as the cause for the observed phenomenon, can be excluded by the absence of independent left and right atrial activation in the electrocardiogram. Case 1 did have minuscule P waves which could have been due to a nonpeptized left atrium and this possibility cannot be ruled out.

Successful cardioversion of patients with mitral stenosis and atrial fibrillation frequently fails to increase cardiac output, and absent diminitive "a" waves in the right and left atria have been noted in this situation. In a recent study of ten patients, atrial transport function was present in eight and absent in two immediately post-cardioversion. Atrial electromechanical dissociation is, therefore, not the usual cause for failure of cardiac output to increase following cardioversion, but it does occur. In most patients this dissociation only persists for several days after cardioversion, whereas in our patients sinus rhythm was present for at least one month prior to catheterization.

Depressed left atrial function has been found in patients with mitral stenosis and an inverse relationship between the severity of the valvular narrowing and the height of the "a" waves has been established. The two patients reported here had longstanding severe mitral stenosis, moderately enlarged left atria and in one case, calcification of the atrial wall. In this situation left atrial contraction is frequently depressed. Electromechanical dissociation is, therefore, the most likely cause of the absence of "a" waves in these two patients.

**References**

5 Scott ME, Patterson GC: Cardiac output after direct circuit conversion of atrial fibrillation. Br Heart J 31:87-90, 1969
Correction of Single and Common Atrium, with Reference to Simplified Terminology*


The anatomic, clinical, radiologic, electrocardiographic, and hemodynamic features of five cases of surgically proved complete absence of the atrial septum are presented. Technical details of the method of correcting this malformation are described. At follow-up, all are alive and well. It is suggested to subdivide this entity into two: single atrium, when complete absence of the atrial septum is found but the atrioventricular valves are normal, and common atrium, in which, in addition to the absence of atrial septum, endocardial cushion defect is also present.

Complete absence of the atrial septum is rare and is considered to be the least common variety of atrial septal defect.1,2 In the literature there would appear to be some nosologic confusion in the use of terms such as cor triloculare-biventriculare, common atrium, or single atrium.

In this article, the term single atrium is used to denote the condition comprising: 1) complete absence of the atrial septum, 2) absence of malformation of the atrioventricular valves and 3) absence of interventricular communication.

The term, common atrium, is used to denote the condition of complete absence of the atrial septum, accompanied by malformation of the atrioventricular valves, with or without interventricular communication.

The conditions of common atrium and ostium primum defect may therefore be considered to constitute two varieties of the partial or complete atrioventricular communis defects.

This report concerns five patients with complete absence of the atrial septum. One case was of the single atrium type, four were of the common atrium variety.

Material

During the period 1967-1970, five patients with complete absence of the atrial septum underwent corrective surgery in our department. Their ages ranged from 8-34 years. There were two males and three females.

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Symptoms of fatigue, dyspnea and peripheral cyanosis were present in all four patients with common atrium, while the patient with single atrium was asymptomatic.

The physical findings in the four patients with common atrium were a fixed split second pulmonary sound, a soft tricuspid diastolic flow murmur; a soft systolic murmur over the pulmonary area; and a grade 2/6 systolic murmur over the cardiac apex, radiating towards the axilla.

In the patient with single atrium the physical findings were similar, except for the absence of the apical systolic murmur. The ECG in all five patients showed a prolonged PR interval, left axis deviation and evidence of right ventricular hypertrophy. The catheterization data are shown in Table 1.

Surgery

Repair was undertaken using extracorporeal circulation, according to techniques previously described.3 Through a wide right atriotomy, the inter-atrial septum was reconstructed employing a Teflon or Dacron patch in all the cases. A cleft in the septal cusps of the mitral valve was present in all four patients with common atrium, and this was repaired first, using three to five interrupted sutures. Thereafter, reconstruction of the atrial septum was effected by a patch, the lower end of which was anchored by three sutures to the tissues between the two atrioventricular valves, and its remaining borders sutured in a continuous fashion to the atrial walls, thus separating the two atria and leaving the coronary sinus in the right atrium.

Temporary atrioventricular dissociation, which converted spontaneously to normal sinus rhythm on the second postoperative day, occurred in one patient. No early or late deaths occurred. All the patients are asymptomatic at follow-up three to six years after surgery.

In three patients with common atrium, an apical murmur of mild mitral incompetence, without hemodynamic significance remained after operation.

Discussion

Ellis et al1 consider complete absence of the atrial septum a variety of atrioventricular canal deformity and believe that atrioventricular valve anomalies are always present in this condition.

We believe that complete absence of the atrial septum may exist alone as a specific entity and unassociated with malformations of the atrioventricular valves. The first report of this condition was made by Lewis et al.,8 who used the term "continuous defect" of the atrial septum. Watkins and Gross4 described two instances of complete absence of the atrial septum among 43 patients who underwent surgical correction of atrial septal defects by a closed technique. Similar cases were also reported by Probyn-Williams,3 Cunningham,8 Dubost and Blondeau,1 and Munoz-Armas et al.8 In none of their cases was an associated anomaly of the atrioventricular valve present. We believe that the term, single atrium, should be restricted to the condition of complete absence of the atrial septum, without endocardial cushion defect.

In atrioventricular canal with complete absence of the atrial septum, partial development of the septal elements may have occurred, but the atrioventricular endocardial cushions have failed to grow adequately, and as a consequence, the endocardial cushions and primitive septal structures failed to fuse. The inevitable tension on the septal structures resulting from further growth of the