Pseudohypertension Secondary to Aortic Valve Prosthesis*

Anthony R. Geraci, M.D. and Herman L. Falsetti, M.D.

A 57-year-old woman was suspected of having systemic hypertension two years after replacement of her aortic valve with a Starr-Edwards prosthesis. The opening and closing sounds of the prosthesis were audible in the antecubital fossa with the blood pressure cuff inflated to 300 mm Hg. Further physical examination and phonocardiography clarified the origin of the sounds leading to the correct diagnosis of pseudohypertension secondary to aortic valve prosthesis. This adds one more cause to the list of possible errors in measuring blood pressure by auscultation.

In the usual clinical situation, blood pressure is measured by auscultation. Although quite adequate in most instances, the measurement of blood pressure may lead to errors which either over or underestimates the actual pressures. The most frequent causes of error are well known: improper cuff sizes, an auscultatory gap, diseases associated with a wide pulse pressure, and the noncompressible brachial artery syndrome.¹

Recently, we have examined a patient in whom hypertension was suspected. When the auscultatory measurement of her blood pressure was compared with other methods of estimating the arterial pressure, it was apparent that the systolic blood pressure obtained by auscultation was incorrect. Further study revealed the auscultatory artefact to be due to transmission of the opening and closing sounds of a prosthetic aortic valve. This report thus adds one more cause to the list of errors in the auscultatory measurement of blood pressure. Although an uncommon occurrence in other patients examined to date, the number of such patients will probably increase in the future as more aortic valve surgery is performed.

Case Report

A 57-year-old white woman was seen in June 1968, two years after replacement of her aortic valve. She had been asymptomatic until March of 1964, when she noted the onset of shortness of breath on exertion. Her disability became progressive, and she was hospitalized in April, 1966.

Physical examination at that time revealed a blood pressure of 115/60 mm Hg in both arms; the pulse was regular, and the jugular venous pulse was normal. On auscultation a grade 4/6 harsh systolic ejection murmur

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The sounds recorded in the antecubital fossa are simultaneous with the ejection click and second heart sound.

was heard at the left sternal border in the second right interspace and radiated well to the neck. A grade 1/6 high pitched, early diastolic murmur was also present along the left sternal border. A diastolic rumble was present at the apex.

Cardiac catheterization revealed severe aortic stenosis with a peak systolic gradient of 100 mm Hg across the aortic valve and mild mitral stenosis. Open heart surgery was performed in May, 1966. The aortic valve was replaced by a number 9E Starr-Edwards ball valve, and an instrument fracture of the mitral valve was performed. She had an uneventful postoperative course. After discharge there was continued improvement in her effort tolerance. Her only complaint was the audible clicks of the prosthetic valve.

Two years later examination revealed sounds in the antecubital fossa with the blood pressure cuff inflated to 300 mm Hg. The brachial artery was compressible, and moderate pressure over the brachial artery obliterated the radial pulse. The systolic blood pressure by palpation was 130 mm Hg and on reinflating the cuff, the Korotkoff sounds were heard at 130 and there was a marked muffling at 90 mm Hg. On the precordial auscultation, the sharp opening click and closing sound of the aortic prosthesis were noted. Also present was an ejection murmur which is often heard in such patients. No diastolic murmurs or other physical signs of aortic regurgitation were observed.

Blood pressures, pulse tracings and phonocardiograms were obtained in the supine position. Hewlett-Packard microphones were placed in the third left intercostal space and the antecubital fossa. The sounds were recorded with a high frequency response Hewlett-Packard preamplifier and a Tektronix storage oscilloscope. The gain and sweep speed were not changed after the sounds were recorded on the first panel of Figure 1.

DISCUSSION

The two sounds generated by the prosthetic valve are easily identified in the pulse tracing and phonocardiograms of Figures 1 and 2. In Figure 1, phonocardiograms recorded simultaneously from the chest and arm revealed the opening click to occur with the upstroke of the carotid and the closing sound to occur before the incisura. Figure 2 demonstrates that these sounds are not obliterated by blood pressure cuff inflation. The first component of the double sound in the antecubital fossa is too early for the first Korotkoff sound. The velocity of conduction of the prosthetic sounds (to the cuff) is more consistent with transmission through the body structures. The marked intensity of the prosthetic sounds is thought to be due to a rapid rate of pressure change at the time of opening and closing of the ball valve and is probably one of the
reasons for the audibility of these sounds in a location distant from their origin.

Korotkoff presented his technique in 1905. His professor insisted that the auscultatory sounds at the brachial artery were generated in the heart and not locally at the artery. Korotkoff stated that they were generated locally. The findings of Geraci and Falsetti in this communication indicate that the professor may have made a valid point, although he was six decades ahead of his time! The advent of prosthetic valves could make the heart sounds appear at the brachial artery.

REFERENCES


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A Simple Appliance for Controlled Oxygen Therapy*

S. K. Jain, M.B.B.S.

A simple appliance for controlled oxygen therapy is described. This could be very useful in the treatment of acute severe respiratory acidosis. It is essentially a device to mix air and oxygen in predetermined proportions with the help of a motor-blower and to deliver it at a flow rate ranging between 35-45 L/min into a plastic mask loosely fitted over the face of the patient.

It was observed that the concentration of the inspired air could be fixed anywhere between 24-37 percent. Further, a flow rate of 35-45 L/min into the face mask was found to be adequate to prevent any significant rebreathing of the patients' own expired air.

Complications of oxygen therapy in acute respiratory failure with deranged ventilatory control may be prevented or reduced in frequency by controlling the concentration of oxygen in the inspired air. The latter author also pointed out that the provision of controlled oxygen concentration in the range of 24-35 percent by the use of prepared oxygen-nitrogen mixtures in compressed cylinders is expensive and inconvenient and some simple devices to mix these gases will be preferable. Venturi mask and an electric blower system have been used for this purpose. This article describes a simple appliance to mix oxygen and air in predetermined proportions to obtain the resultant concentration of oxygen in the inspired air anywhere between 24-37 percent with a high degree of accuracy. Detailed clinical trials using this equipment, in acute respiratory failure, will be reported later.

Material and Methods

This equipment (Fig 1 and 2) was designed and made at the V. P. Chest Institute.

Motor-Blower Unit: This consists of a completely enclosed fan with aluminium fins coupled to the output shaft of a fractional horsepower motor and the rheostat. The latter are separately sealed in order to prevent any possible hazard of fire. The blower housing, which is completely air-tight, is equipped with intake and outlet tubings each having 25mm inside diameter. While the intake side is connected to the air-oxygen mixing cone, the outlet is connected to a corrugated breathing tube of a suitable length. The operation is quiet and the flow can be easily regulated between 30-45 liters per minute.

Air-Oxygen Mixing Cone: This has a base of 8.9 cm and a similar slant height. The apex leads into a tube, 3.8 cm long and having an inside diameter of 3.1 cm. This is further connected to the intake tube of the motor-blower unit. The circular base plate has two tubes for the inlet of air and oxygen respectively, fitted eccentrically but equidistant from the margins. The air-inlet tube, which is 4 cm long and has an inside diameter of 2.064 cm, is permanently fixed.

Table 1—Mean (± SD) concentration of oxygen in the air-oxygen mixture (flow rate ranging between 30–45 L/min) using different oxygen-inlet tubes.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Inside diam. of oxygen inlet tube (mm)</th>
<th>Number of observations</th>
<th>Mean concentration of oxygen ± SD</th>
<th>Coeff. of variation %</th>
<th>O2 flow rate L/min</th>
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<tr>
<td>1</td>
<td>4.76</td>
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<td>24.0 ± 0.0771</td>
<td>0.3215</td>
<td>4.0</td>
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<td>2</td>
<td>5.95</td>
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<td>3</td>
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<td>4</td>
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<td>0.8290</td>
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<tr>
<td>5</td>
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<td>6</td>
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<td>12</td>
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<td>1.2334</td>
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<tr>
<td>7</td>
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</tr>
</tbody>
</table>

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