Blood Flow Velocity during Ventricular Fibrillation in Man
Measured with the Doppler Flowmeter Technique*

Alberto Benchimol, M.D., Kenneth B. Desser, M.D., and
James Schumacher, M.D.

The clinical implication of ventricular fibrillation is well known. It has been stated that the chaotic nature of ventricular contraction prevents the development of sufficient intraventricular pressure to allow forward flow during this arrhythmia. We report here measurement of dorsalis pedis artery and aortic blood flow velocity in two patients with transient ventricular fibrillation utilizing the Doppler transcutaneous and catheter flowmeter techniques, respectively.

The Doppler flowmeter technique is based on the principle that reflected ultrasound will change frequency depending on the velocity of the target, i.e., blood cells. The transcutaneous flowmeter is placed on the skin overlying the vessel under study; signals representing blood flow velocity are monitored audibly, oscillographically and recorded. Aortic blood flow velocity is measured by positioning a Doppler flowmeter catheter in the ascending aorta via a brachial artery cutdown, as described previously.

Case 1

A 52-year-old woman underwent cardiac catheterization for suspected patent ductus arteriosus. During positioning of a catheter in the left ventricle, the patient developed salvos of ventricular premature beats followed shortly by ventricular fibrillation, while transcutaneous measurement of dorsalis pedis artery was being continually monitored. During repetitive ventricular extrasystoles dorsalis pedis artery flow velocity was irregular, with a 50-100 percent decrease in flow velocity. With the onset of ventricular fibrillation, there was an abrupt fall in peak systolic flow velocity to near zero baseline levels. Of interest was the unexpected appearance of systolic waves during a period of "coarse" high voltage ventricular fibrillation (Fig 1). These wave forms attained values of 35-50 percent compared with control sinus beats. Application of two 200 watt second precordial electrical shocks terminated the ventricular fibrillation. With subsequent sinus beats, blood velocity immediately returned to prefibrillation levels.

Case 2

A 57-year-old man with recurrent chest pain underwent cardiac catheterization. Coronary cineangiography revealed significant obstruction to all three major coronary arteries. During the procedure, the patient experienced a burst of ventricular tachycardia followed by ventricular fibrillation. During ventricular tachycardia, aortic flow velocity became irregular, with many beats resulting in no measurable flow. Ventricular fibrillation was associated with low amplitude systolic blood velocity, and in general each systolic wave corresponded to a fibrillatory deflection on the electrocardiogram. Of interest was an observed systolic blood velocity of 50-60 percent of prefibrillation levels just preceding spontaneous conversion back to sinus rhythm (Fig 2).

The above findings suggest that under certain conditions, the human heart can eject blood into the systemic circulation during ventricular fibrillation. It has been demonstrated in experimental animals that the fibrillatory ventricular myocardium is in a
complex state of sustained contraction. Irregular coarse oscillations, seen in early ventricular fibrillation, may effect a forward propulsion of blood by virtue of semicoordinated muscular contraction. This minimal flow, however, is apparently of no benefit, since in most cases, low amplitude ventricular fibrillation then ensues with demise of the animal. Although little is known concerning atrial activity during closed chest ventricular fibrillation in man, induced ventricular fibrillation in dogs leaves the atria contracting regularly and forcefully for as long as 30 minutes. The large ventricular
residual volume consequent to ventricular fibrillation combined with forceful atrial contraction and an open aortic valve could result in forward propulsion of blood. The former explanation appears most likely on the basis of the findings of appreciable systolic aortic blood velocity on a beat-to-beat basis during ventricular fibrillation in Case 2.

The presence of significant aortic flow velocity as a prelude to spontaneous conversion of ventricular fibrillation in this latter case remains unexplained. It is tempting to invoke some type of muscular potentiation which in turn enhances aortic and coronary blood flow with resulting spontaneous conversion to sinus rhythm.

Cardiac slowing and immediate restoration of the dorsalis pedis artery blood velocity in Case 1 to prefibrillation levels after electrical defibrillation is compatible with cholinergic mediated negative chronotropic and adrenergic mediated positive inotropic responses recently noted in defibrillated animals.6

In conclusion, it appears that the Doppler flowmeter technique is a valuable method for the study of blood flow velocity during life-threatening arrhythmias in man. Reliable monitoring of peripheral arterial blood flow velocity in patients at risk with the non-invasive transcutaneous flowmeter (Case 1) may aid in clarifying unanswered questions concerning ventricular fibrillation in man.

REFERENCES

Reprint requests: Dr. Benchimol, 1033 McDowell Road, Phoenix 85032

GOLD CALLED GUANO

One of the principal sources of wealth of Peru lies in guano, the highly exploitable layers of droppings of a few sea birds. Three of the pelecaniforms represent the largest producers of guano: the Peruvian cormorant (Phalacrocorax bougainvillei) is responsible for 85 percent of the current guano stock, the variagated booby (Sula variegata) for 10 percent and the pelican (Pelecanus occidentalis) for 5 percent. Current figures put the quantity of guano produced annually in Peru at 350,000 tons. In the Islas de Chincha alone, the colonies of cormorants are made up of four to five million individuals. During the nesting period there are about three nests per square yard. Since a cormorant pair raises an average of two chicks, this brings the density to twelve birds per square yard. According to rough estimates, a colony of cormorants can eat more than one thousand tons of fish a day. The cormorants drift with the waves in flocks often as large as found on land. Each bird produces 35 pounds of guano each season. It is believed that each ton of guano requires the consumption of about fifteen tons of fish and it is supposed that two-thirds of all droppings fall on land.

Dorst, J: The Continents We Live On—South America, New York, Random House, 1967

CHEST, VOL. 60, NO. 3, SEPTEMBER 1971