

# SHORT COMMUNICATION

## The "Valve" of the Ductus Arteriosus — An Enigma

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THE accounts of the anatomy of the ductus arteriosus in a number of well-known textbooks on congenital heart disease are notably brief and in none is there mention of a "valve". Similarly, in the major textbooks of anatomy and embryology we have been unable to find any reference to it. However, Barclay, Franklin and Prichard<sup>1</sup> in their monograph on the fetal circulation did discuss briefly the possible physiological implications of such a structure which they recognized as a ridge at the union of the ductus arteriosus and the first part of the aorta. The structure was of sufficient interest to them that they felt it merited a name, and for it they coined the term "crista reuniens". They had seen the crista in the newborn of numerous species including lions, gorillas and tapirs.

The knowledge of a flap or membrane at the aortic end of the ductus has a venerable history. Vesalius in 1561, after he had produced his monumental "Fabrica", studied a number of human fetuses and described a membrane similar to that of the foramen ovale, which was arranged around the aortic opening of the ductus. A similar flap was described by Arantius in 1564. Franklin<sup>2</sup> has pointed out how Vesalius' suggestion that a circular membrane occluded the aortic end of the ductus at birth was assailed vigorously by Carcano in 1574. The latter had undertaken a thorough examination of fetal cardiac unions and could not find evidence of a membrane capable of preventing reflux.

Three hundred years passed without further comment on the valve until, in 1894, Strassmann<sup>3</sup> postulated the ingenious theory that immediate closure of the ductus arteriosus is effected by means of a valve-like intimal fold at the aortic end. The increased aortic blood pressure after birth was thought to close the valve and prevent reflux into the pulmonary artery (Fig. 1). Strassmann thought that he had demonstrated the effectiveness of the valve by injection studies, because he was unable to fill the ductus from the

aorta while he filled it easily from the pulmonary artery.

Nobak and Rehman<sup>5</sup> studied the anatomy of the ductus arteriosus in 100 fetal and newborn cadavers. In 25% they noted a ridge of tissue projecting into the lumen of the vessel about mid-way between pulmonary and aortic ends and they called this ridge a "valve". A spur-like projection of tissue at the aortic end was seen by Sciacca and Condorelli<sup>6</sup> in a number of guinea-pig fetuses. However, they were emphatic that this was not a valve because the centre of the tongue of tissue was directly continuous with the adventitia of the ductus and of the aorta. We think that this observation has no bearing on its possible functional significance.

Our interest in this subject was aroused when in the course of studying the ductus in newborn rabbits we constantly found a flap-like structure projecting into the aortic lumen (Fig. 2). In all specimens this tongue of tissue was large enough to occlude the opening of the ductus into the aorta when the pressure in the aorta rose and forced the valve against the wall of the aorta and across the opening. The same observation might be made of the flaps seen in the illustrations published in Sciacca and Condorelli's review. Woodbury, Hamilton and Woods<sup>7</sup> also

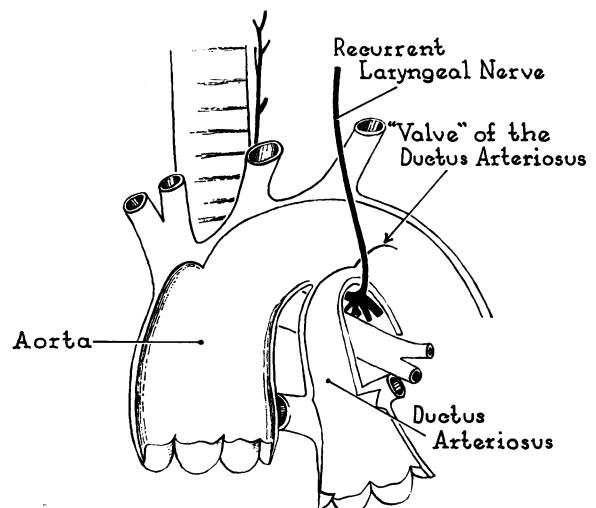


Fig. 1.—Copy of Strassmann's 1894 drawing of the ductus arteriosus of a newborn child, with the "valve" shown at the aortic end.

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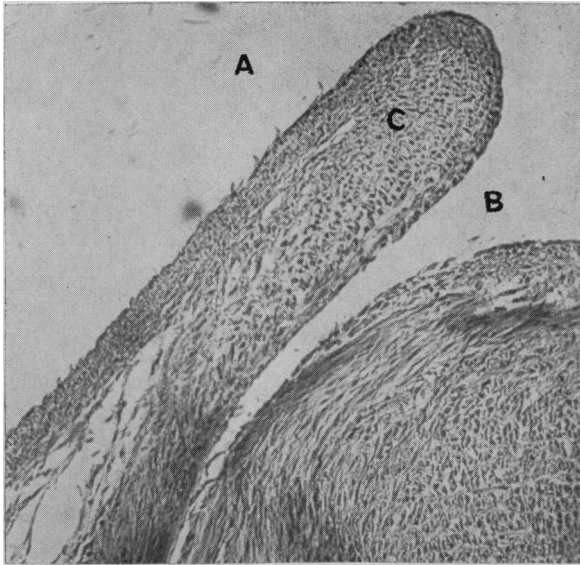


Fig. 2.—The confluence of the ductus arteriosus with the aorta in a newborn rabbit ( $\times 125$ ). (A) Lumen of aorta. (B) Lumen of the ductus. (C) "Valve".

reported the existence of a "functional valve" in the fetal rabbit, and later they mentioned the existence of this structure in the dog.<sup>8</sup>

Having ourselves seen a valve in newborn rabbits, we examined the ductus arteriosus in two human stillborn fetuses, one full-term (Fig. 4a) and one of about six months' gestation. In both of these, the opening of the ductus into the aorta was guarded on the cranial margin by a crescentic fold of tissue with its free edge directed downstream (Fig. 3). It seemed conceivable that with a rise in aortic pressure and a fall in pulmonary artery pressure at birth, this fold could occlude the aortic end of the ductus.

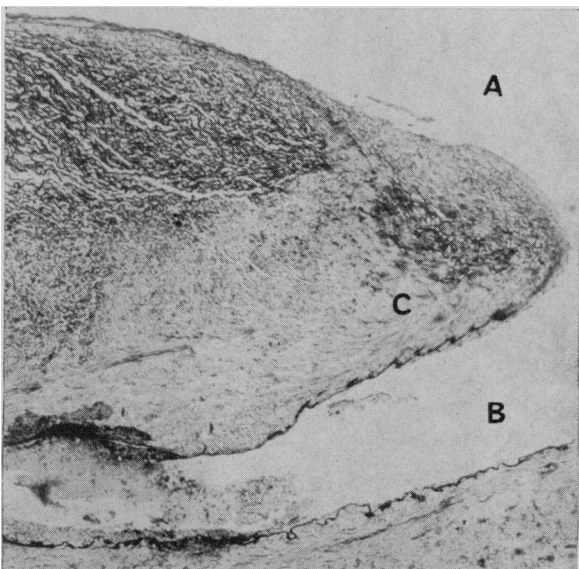


Fig. 3.—The confluence of the ductus arteriosus with the aorta in a newborn human ( $\times 50$ ). (A) Lumen of aorta. (B) Lumen of ductus. (C) "Valve".

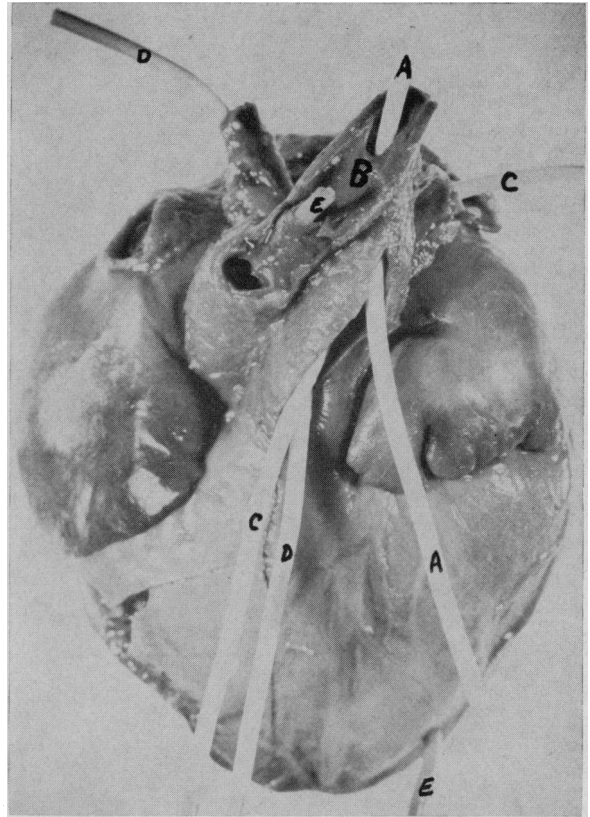


Fig. 4a.—Heart of stillborn full-term fetus at birth:—A plastic-covered wire running through the ductus; B—the valve of the duct; C—wire running through the main pulmonary artery and through the left branch of the pulmonary artery; D—the wire running from the main pulmonary artery through the right branch; and E—the wire entering the left ventricle and emerging in the aorta. Some of the adventitia at the base of the aorta has been dissected away.

Histologically, the structure of the valve in the human looked very similar to that seen in the rabbit (Figs. 4a and 4b).

By describing the reports of others and our own observations we do not wish to imply that

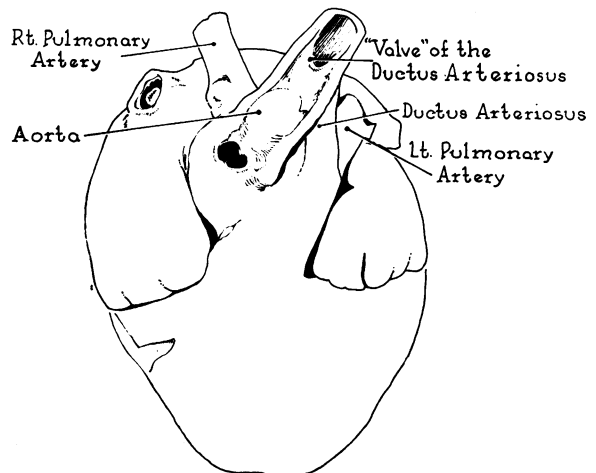


Fig. 4b.—Schematic drawing of the heart of the newborn child. The "valve" of the ductus arteriosus at the aortic end is evident. (Drawn by F. A. Edwards.)

the valve is necessarily an integral part of the mechanism of closure. However, the presence of such a flap may sufficiently impede the flow of blood through the ductus, immediately after birth, so as to allow the mechanism of closure to begin. Clearly, even if this were so, the presence of a flap or valve in the vessel cannot explain or throw light on the structural changes which take place within the ductus itself in the days and weeks following birth. In fact, the valve still remains an enigma!

**Summary** The existence of a flap-like structure at the aortic end of the ductus arteriosus was recorded in the medical literature more than four centuries ago. It has received little attention in recent years, although references to a "valve" of the ductus appear sporadically.

The authors have observed this "valve" in newborn rabbits and in stillborn human fetuses.

The functional significance of this structure is briefly discussed.

**Résumé** L'existence d'une structure anatomique en forme de rabat, à l'extrémité aortique du canal artériel a déjà été signalée dans la littérature médicale il y a plus de quatre siècles. Au cours des dernières années, on n'y a guère porté attention bien que, sporadiquement on mentionne une valvule du canal artériel.

Les auteurs ont observé cette "valvule" chez des lapins nouveau-nés et chez des fœtus mort-nés.

Ils exposent brièvement le rôle fonctionnel de cette structure.

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