lactic properties to humans.

Summary. 1. The blood-group-specific substances present in meconium from a series of 53 infants were found to correspond to the blood type of the baby and its ability to secrete blood group material in its saliva in all except 2 cases in which O activity was demonstrated in the meconium but could not be found in the saliva. 2. The meconiums of blood groups A and B were more active than those of groups AB or O. 3. No M or N activity could be demonstrated in meconium. 4. The blood-group-specific substances in amniotic fluid corresponded with the blood type of the baby and not that of the mother.

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Excitation of the Isolated Ventricular Septum of the Heart. (18697)

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One of the basic assumptions traditional in electrocardiographic interpretation is that the excitatory process in the ventricular septum starts symmetrically on either side and progresses toward its center. The potentials produced in the ventricular septum might then so neutralize one another that the manifest electromotive force recorded at a distance would be negligible. This hypothesis of ventricular septal excitation is most useful in the explanation of many electrocardiographic phenomena, but it has not been tested experimentally in any thorough manner.

In the dog's heart the arrangement of the coronary arteries includes a large septal branch which arises near the origin of the left coronary artery and passes directly into the musculature of the septum. With such an arterial supply insured, attempts were invited to perfuse the heart by the Langendorff technic with the free walls of the right and left ventricles removed. Under such circumstances the surfaces of the right and left side of the septum could be explored by an electrode under direct vision and the electrical activity recorded.

Methods. The heart was suspended from a cannula, tied in the aorta, through which the perfusate was introduced under pressure. Tyrode's solution with 1% added glucose was used routinely, though in the latter experiments approximately 100 cc of centrifuged erythrocytes were added to the total volume of perfusate (usually 2,000 cc). The lower one third to one half of the organ was submerged in the perfusate in a container beneath the heart. The distant electrode was placed in a corner of the container at a distance of approximately 15 cm from the heart. The reference tracing was uniformly obtained by recording the potentials between a wire electrode about the aorta and adjacent atria and a distant electrode. Relative positivity of the aortic electrode was represented by an upward deflection on the finished record. After stabilization of the heart rate the free walls of the right or left ventricle or both were excised nearly up to the atrioventricular groove. Routinely a band of ventricular muscle remained along the atrioventricular sulcus. This ridge of muscle was also removed in the later part of 2 experiments without alteration of the pattern of the reference tracing. The exploration of the septal surfaces was carried out by 3 technics: (1) by a bipolar method, in which the points from which the electrograms were obtained were approximately 1 mm distant from one another; (2) by a unipolar method in which a single electrode was used to explore the septal surface, and the potentials between it and the distant electrode were recorded; (3) by a bipolar method of recording wherein two electrodes were placed on opposing sides of the septum. All the utilizable records were obtained within one-half hour after the removal of the heart from the animal.

The recording equipment was a Sanborn

Tribeam electrocardiograph locally modified. The responses of the two electrocardiographic recording systems were similar. The response to a 1 mv sine wave input began to decrease appreciably after 30 cycles/sec.; at 40 cycles /sec. it was 75%; and at 75 cycles/sec. it was 60% of the DC response. The camera speed was 75 mm/sec. and the standardization was 5 mv = 1 cm. Measurements were made to the nearest 0.25 mm using a 0.5 mm grid and a hand lens. The measurements were then converted to time and reported to the nearest 0.001 sec. (1 mm = 0.0133 sec.).

Results. Perfusion of the heart was initially successful in 15 experiments, but in only 6 were results sufficiently adequate for analysis. In the others either the early development of fibrillation prevented adequate records or there was absence of normal sinus conducted beats. In many of the preparations nodal rhythm appeared as a stable and inconvertible mechanism, and in others there was partial or complete heart block. Measurements were made on those records where such abnormalities had not appeared.

The first observation was the consistent finding that the potentials of the isolated septum were such that the manifest vector was of considerable voltage and oriented positive toward the base and negative toward the apex. No shortening of the QRS duration occurred in any experiment after removal of the free walls of both ventricles.

The second finding was that in all preparations there was evidence that predominantly the left side of the septum was activated early and that the arrival of the excitatory process was relatively delayed and more irregularly deployed over the right side of the septum. These results in the first experiments were confusing in that it appeared that the hearts were showing spontaneous right bundle-branch block. The first part of the right side of the ventricular surface to be excited was either the middle or the lowermost portion. The upper part of the right side of the septum was activated relatively late, and in one experiment the upper left side was relatively late in its activation. The septal side of the conus of the right ventricle varied in its time

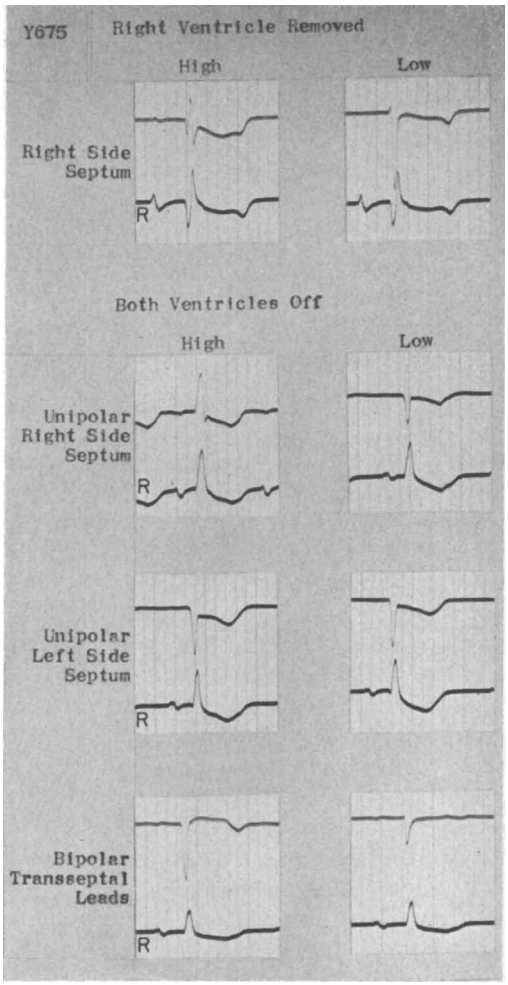

FIG. 1
Electrograms of the perfused septum, explained in text.

of activation in various hearts, activation usually being relatively early.

A third finding was that it was impossible to obtain exact reproducibility of results over a period of time during which electrodes were removed and replaced on areas believed to be the same by visual inspection. In repeated tests in the same preparation the times of arrival of the excitatory state varied in one instance 0.010 second on the right side of the septum in an area which if not the same must have been closely adjacent. An illustration of the type of records obtained is given in Fig. 1, and the times of septal excitation in three experiments are given in Table I.

TABLE I. Ventricular Septal Activation: Bipolar Exploration: Time of Deflection in Exploratory Electrogram from Onset of QRS in Reference Tracing.

	Animal Y37		Animal Y675		Animal Y683
	Right	Left	Right	Left	Right
Conus area			.018		.016
High	.034	.025	.034	−.007	.013
Mid	.002	−.003	.020	−.010	.030
Low	.001	.009	.011	−.007	.012

A fourth finding was that an incision into the septum calculated to produce right bundle-branch block caused delay in the excitation reaching the tricuspid (upper) and conus portions of the septum, with little change in the time of excitation of the apical area.

Comment. The observations recorded indicate that the excitation of the ventricular septum is a more complicated process than a simple perpendicular spread from the opposing endocardial surfaces. The possible criticism that the hearts in these experiments were not in sufficiently good physiologic state for the data to be applied to the normal animal can be answered only by stating that sinus rhythm, normal atrioventricular and ventricular conduction were present and the ventricular mass contracted vigorously. It might be contended that in the excision of the right ventricle there was accidental damage to the right bundle branch. Every effort was made to avoid injury to the septum and none was apparent after the free wall had been excised. The experiments indicate a variability in the patterns of excitation of the ventricular septum from animal to animal. The constant pattern of the bipolar electrogram of the isolated septum with the positive end of the vector toward the base of the heart can best be explained by the excitatory process spreading away from the apex in at least a large number of its component parts.

The results obtained in our experiments are not without support from the early workers in the field. To quote Lewis and Rothschild(1), "Our readings for the right side of the septum are variable 0.0033 and 0.0060 for the mid-septal area and 0.0243 and 0.0144 for the high septal region." They explained the late activation of the high right septal surface by a lack of Purkinje fibers in this area. Recent workers, as Kossmann and associates(2), have encountered large moderately late electromotive forces in the outflow tract of the right ventricle and have suggested that these might be related to excitation of a band of right ventricular muscle called the crista ventricularis.

Pruitt and associates(3) have reported investigations indicating that the excitatory process in ventricular muscle travels more rapidly when spreading in the direction of the predominant long axis of the fibers. It seems pertinent in this regard that some of the superficial muscle fibers of the upper left septum spiral deeply in the septum to appear near the endocardium of the apex of the right ventricle. Clinically, the fact that the electrocardiographic picture of right bundle-branch block is quite commonly associated with anteroseptal infarction is of interest(4) and may possibly be related to a predominant left-to-right septal activation in man.

Conclusions. 1. It is possible to obtain electrograms on the isolated perfused dog's ventricular septum, and these show a reproducible pattern. 2. The records indicate that the excitatory process in these experiments traveled in a complicated fashion and the pattern varied somewhat from animal to animal. In some of the experiments the excitatory pathways varied over a period of time. As a basic rule, the left side of the septum was found to be activated early and the upper right side late. 3. The apparent absence of septal electromotive forces in electrocardiograms recorded by usual clinical methods, which has been explained by neutralization of potentials spreading inward from each side, is not supported by these preliminary observations on the isolated septum.

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