Direct Measurement of Conduction Velocity in *In situ* Specialized Conducting System of Mammalian Heart.* (25141)

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Earlier attempts(1,2) to determine conduction velocity in the *in situ* specialized conducting system were made on excised hearts perfused with saline solutions: In the first case the value obtained was 0.75 m/sec, in the second 2-3.5 m/sec. Measurements made *in vitro* on isolated bundles of Purkinje fibers(3, 4) have been restricted to a single portion of the conducting system, the so-called false tendons. By using a pump-oxygenator which supplies both a total body perfusion and a Langendorf perfusion of the heart we found it possible to expose any part of the specialized conducting system and to record electrical activity under direct vision(5).

Methods. In these experiments large mongrel dogs were anesthetized with pentobarbital. After total cardiopulmonary by-pass the right atrium and right and left ventricles were opened by incisions in their free walls. The bundle of His, right and left bundle branches, free-running Purkinje fibers and their distal insertions were located by known anatomical landmarks and on the basis of local bipolar electrograms recorded through a freely movable exploring electrode. Small plastic electrodes containing from 3 to 16 fine silver contacts were then attached at desired locations by fine silk sutures which passed through the endocardium 2-4 mm from the recording site. Bipolar electrograms recorded simultaneously from fixed and exploring electrodes were displayed on an 8 beam oscilloscope and photographed on paper moving at 200 mm/sec. Temperature of endocardium at each recording site was determined from time to time by a small thermistor. In some experiments additional electrodes were attached to the atrium and ventricle for electrical stimulation. Distances between recording sites were measured directly at end of each experiment.

Results. Identification of local electrograms as records of electrical activity of the specialized conducting system rests upon both anatomical and physiological considerations. Action potentials of the His bundle and other portions of the conducting system are recorded from appropriate anatomical locations where well-defined tracts of the conducting system are known to lie. Clear-cut action potentials with rapid deflections and short durations are noted (Figs. 1 and 2) and it can be seen that these action potentials follow atrial activity and precede ventricular activity. When the vagus nerve is stimulated (Fig. 1 b) the interval between atrial activity and the action potential of the His bundle is greatly prolonged but no change is noted in the interval between activity in the bundle of His and the peripheral Purkinje fibers or ventricular myocardium. Also, during retrograde excitation (Fig. 1 d) the sequence of action potentials recorded from ventricle, peripheral Purkinje fibers, bundle of His and atrium shows the appropriate change.

The records shown in Fig. 2 permit determination of conduction velocity from the bundle of His to emergence of right and left bundle branches and from these sites to points, in the left ventricle, at which the anterior false tendon emerges from the septum and enters the papillary muscle and, in the right ventricle, to junction of Purkinje fibers with the anterior papillary muscle and free ventricular wall. Intervals and distances are listed in Table I. In this experiment, corresponding to records of Fig. 2, at heart temperature of 36°C, the conduction velocity from the bundle of His to left and right bundle branches is 1.2 - 1.3 m/sec. In contrast, conduction velocity in the free-running false tendons of left ventricle is 4.0 - 4.1 m/sec and in the right

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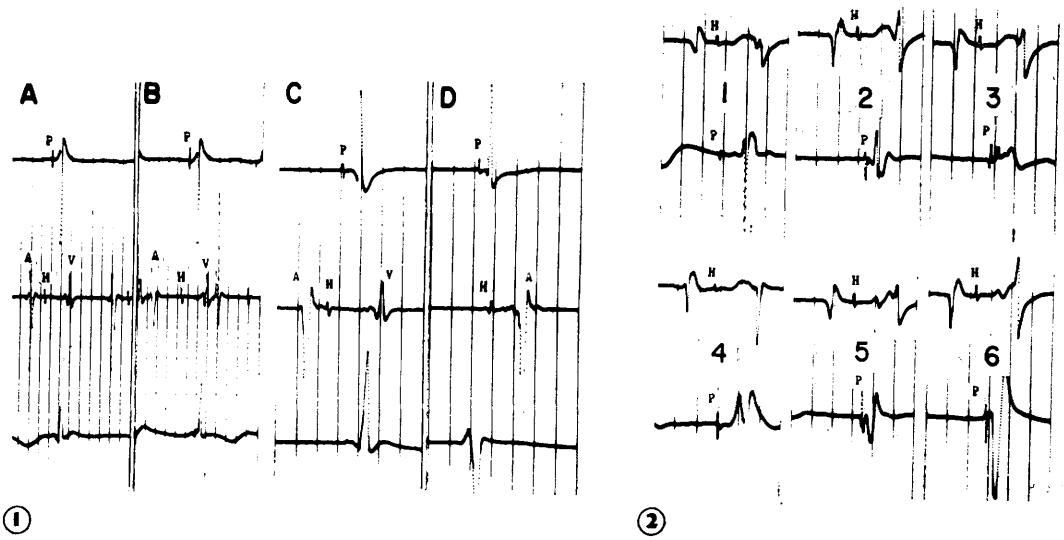

FIG. 1. Bipolar electrograms recorded from left interventricular septum (top trace), bundle of His (middle trace) and left anterior papillary muscle. P = Purkinje fiber electrogram; H = His bundle electrogram; A = Atrial electrogram; V = Ventricular electrogram. Records in A obtained prior to and in B during stimulation of left vagus nerve. Paper speed 100 mm/sec., time lines = 100 msec. C and D bipolar electrograms from same locations as in A and B recorded from a different heart. Records in C obtained normal sinus rhythm and in D during ventricular driving. Paper speed 200 mm/sec., time lines = 100 msec.

FIG. 2. Bipolar electrograms recorded from bundle of His (top trace) and peripheral Purkinje fibers at the following locations in one heart: 1—Right bundle branch; 2—junction of moderator band with right anterior papillary muscle; 3—junction of right false tendon with free ventricular wall; 4—left bundle branch; 5—emergence of left anterior false tendon from septum; 6—junction of anterior false tendon with left anterior papillary muscle. Changes in configuration of the ventricular complex on top trace are caused largely by changes in position of heart. Paper speed 200 mm/sec., time lines = 100 msec.

ventricle 4 m/sec. Average conduction velocity from the bundle of His to termination of the free-running Purkinje system is 2.45 m/sec for the right ventricle and 2.6 m/sec for the left ventricle. Similar values for conduction velocity in the bundle of His and free-running Purkinje fibers have been obtained in other experiments. In the former the range is from 1 to 1.5 m/sec and in the latter from 3 to 4 m/sec. When regular driving stimuli are applied to the ventricle at rates from 60-150/minute conduction velocity within the Purkinje system and bundle of His in the retrograde direction is the same as during normal activation. The maximum value found by Maeno(2) for conduction velocity in the *in situ* false tendons of the excised, perfused dog heart is of the same order of magnitude as our results.

TABLE I. Conduction Velocity in Specialized Fibers.

Location	Conduction time, msec.	Conduction distance, mm	Velocity, m/sec.
His to lt. bundle branch	7.5	9	1.2
His to rt. bundle branch	10	13	1.3
Lt. ant. false tendon	2.25	9	4.0
Lt. post. false tendon	7	29	4.1
Rt. false tendon	3	12	4.0

Summary. By use of a pump-oxygenator and cardiopulmonary bypass, bipolar electrograms have been recorded under direct vision from the bundle of His, the right and left bundle branches and peripheral Purkinje system of dog hearts. Conduction velocity from the bundle of His to bundle branches is 1.0-1.5 m/sec, while in the false tendons this value is 3-4 m/sec at 36°C.

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Variations in Post-Weaning Development of Ruminal Mucosa in Lambs.* (25142)

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Earlier workers(1-5) have suggested that diet has some effect on rumen development. This was not convincingly shown however, until reports of Warner and coworkers(6-8), which strongly indicated that chemical factors, probably in the form of active microbial fermentation products, act as stimulants for development of the ruminal papillae. The literature, however, appears devoid of reference to either qualitative or quantitative relationship of development of ruminal mucosa to post-weaning growth patterns in the animal. The stimulus for the present study developed from observations of rumina of sheep slaughtered at termination of an earlier feeding trial. Some lambs in the earlier trial had gained poorly, and a striking relationship existed between gain and ruminal development although all lambs were of an age and were receiving a diet which was expected to have conditioned full development of the rumen. The sheep which gained weight slowly had poor development of the rumen while more rapidly gaining ones had rumina which had thickened mucosae with well-developed papillae. As far as we were aware, such a relationship between structural development of a tissue and rate of gain of the animal had not been previously reported.

Procedure. Detailed observations were made on rumina from 42 feed-lot lambs upon slaughter at the end of a 114-day feeding period. The lambs weighed an average of 62.1 lb (range of 49-90 lb) at the beginning of the feeding trial, prior to which they had been maintained on a diet of mixed forages. Weight and gain data were available on all animals. The self-fed basal diet consisted of 25% oat straw, 24% beet pulp, 14% wheat, 16% oats, 18% linseed meal, and 4% sucrose. Stabilized Vit. A (Chas. Pfizer & Co., Inc.) was supplemented at the rate of 650,000 I.U. per ton of feed. Other than addition of 48 lb of K_2HPO_4 per ton of feed (added in an attempt to induce urinary calculi formation), the diet may be considered adequate. The sheep were fed in 5 groups, their diets differing only in antibiotic content (Table I). The antibiotics chlortetracycline and oxytetracycline were supplied as crude supplements (Aurofac and TM-10, respectively). As soon as possible after evisceration, rumen and reticulum were tied off, slit at the dorsal midline, emptied, and washed. Weights of the emptied whole ruminoreticulum were taken and gross observations made of color, length, and density of papillae of the various rumina. Sections of tissue were immediately removed from the anterioventral sac of the rumen and placed in 10% formalin. Formalin fixed sections from 28 of the animals were later separated into 2 sections: a "mucosal" layer, consisting of the epithelial lining, submucosa, muscularis mu-

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