Intrabronchial Electrocardiography
A Preliminary Report

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The Einthoven hypothesis implies that differences in the conductivity of body tissues are not sufficiently great to invalidate the concept that the body is a homogeneous volume conductor. Some investigators believe the lungs are sufficiently poor conductors to make questionable the concept that the body can be regarded as a homogeneous volume conductor. Intrabronchial electrocardiography is presented as a possible method for studying this problem. In ten individuals without manifest cardiac disease the distribution of potential variations in the lungs as manifested by the QRS complexes corresponded approximately and qualitatively with the distribution of the QRS complexes recorded from the body surfaces.

It is the purpose of this paper to describe our preliminary experiences with the technique of intrabronchial electrocardiography. We were prompted to employ this method for the investigation of the distribution of potential variations associated with cardiac contraction in the hope of being able to obtain evidence for or against the field theory of electrocardiography.

Material and Methods

In 4 anesthetized dogs a No. 8 ureteral catheter with an electrode at the tip was passed through a tracheotomy tube into the periphery of the bronchial tree. In 5 human subjects a bronchosopic forceps insulating except at the tip was introduced through a laryngoscope. In one of these, fluoroscopic guidance was used to check the position of the electrode; in the others, this position could be roughly estimated. In 5 human subjects a No. 8 ureteral catheter with an electrode at the tip was passed without instrumentation through the oropharynx, larynx and trachea into the bronchi and the position of the electrode was observed fluoroscopically in the anteroposterior and lateral views and recorded on x-ray films. Basal sedation with pentobarbital and topical anesthesia with 1 per cent cocaine were used in the human subjects. In the last 4 human subjects studied all electrocardiograms and films were made in the upright position. In the other subjects all studies were made in the recumbent position. It is very important to keep the position of the body and the phase of respiration constant when comparing the leads from the surface of the body with leads made from within the left lung. It is well known that extremity leads can be made to vary in amplitude and contour by changes in respiration and body position, the degree of variation depending upon the individual subject. Furthermore we found that aVL varied significantly even when the position of the shoulders was changed with relation to the body. Failure to control these sources of variation would lead to gross error in evaluation of results. All records were made on a direct writing electrocardiograph.* Attention should be called to the fact that the postero-anterior x-ray film does not supply sufficient information to localize the electrode. It frequently lies in the posterior portion of the lung and therefore may be farther from the heart than would seem to be the case in the postero-anterior film. The length of the time available for intrabronchial exploration is limited by the duration of the anesthesia and the radiographic exposure.

The intrabronchial potential variations were recorded, using a central terminal as an "indifferent" electrode and were compared with central terminal leads from the extremities, the standard precordial positions, and other exploratory leads from the thoracic wall, abdomen, and back.

Results

From the left lower lobe bronchi positive QRS complexes were obtained in both human subjects and dogs which were intermediate in size between that of the largest complex obtained from a precordial position (usually V4 or V5) and that obtained from the left mid or posterior axillary position taken at the same level as the intrabronchial electrode. As the electrode was withdrawn upward toward the bifurcation of the trachea the QRS complex became negative. From the right lung the QRS complexes were principally negative and were intermediate in size between V1 and V2 and leads from the right mid axilla taken at the same level as the intrabronchial electrode (See figures 1–2–3).

* Viso-cardiette, The Sanborn Company.
In four individuals extensive body exploration was performed. The electrical field of the heart as manifested by the body-surface QRS complex patterns was mapped out. This field could be divided into a predominantly positive zone manifested chiefly by R waves, a predominantly negative zone manifested chiefly by S waves or Q waves, and an intermediate or transitional zone of equally biphatic patterns extending in a fairly regular manner between the positive and negative zones. This field was usually eccentric, having a larger negative than positive area. This distribution of surface patterns has previously been described by Ashman and associates' and Grant.2 For purposes of orientation the transitional zone of the QRS complex obtained on the body surface was visually extended as a plane projecting through the body and dividing it into positive and negative zones. When the intrabronchial electrode lay clearly on the positive side of the transitional zone the complexes recorded were positive consisting chiefly of R waves. When the intrabronchial electrode lay clearly on the negative side of the transitional zone the complex was chiefly negative consisting of an S or a Q wave. When the electrode was in or very near the projection of the transitional zone the complexes were equally biphatic.

In figure 1 the opaque band diagonally across the left lower lung field represents the anterior margin of the body-surface transitional zone and the upper band represents the posterior margin of the transitional zone. The imaginary plane of the transitional zone extends from the lower band upward and backward through the lung to the upper band. The intrabronchial electrode is seen behind the lower band but since the electrode is half way between the anterior and posterior chest wall it lay clearly below the transitional zone plane at that point and recorded the positive complex shown in figure 2. The biphatic complex in figure 2 was recorded when the electrode was withdrawn to a position about one-half the distance between the upper and lower bands, and above this negative complexes were obtained. From the middle of the right lung a negative complex was obtained as shown in figure 2. Figure 3 represents the records of another individual obtained by intrabronchial exploration similar to that described for figures 1 and 2.

In one individual with an unusually vertical heart we were unable to introduce a No. 8 catheter into the left lower lung field far enough to reach the positive side of the transitional zone and therefore only negative complexes were obtained. In an individual with a horizontal heart positive complexes were obtained not only from a left lower lobe bronchus but also from a left upper lobe bronchus as shown in figure 3.

At this point we can not say whether the transitional zone is always a fairly regular plane or a zone of variable regularity and depth. To determine this would require further study which we expect to undertake in the near future.

**Summary and Conclusions**

1. The technic of intrabronchial electrocardiography provides a means of exploring an interesting region of the body, the lungs, the electrical properties of which are a matter of controversy.4 We have obtained the same type of information from lung puncture in dogs with a solid needle insulated except at the tip but we believe the intrabronchial method is more physiologic and obviates the possible complications of pneumothorax and intrapulmonary hemorrhage.

2. While the analysis of our results so far has been limited to the contours of the QRS complex rather than absolute magnitude the
results indicate that the distribution of potential variation in the lungs corresponds approximately and qualitatively with the distribution of potential variations recorded from the body surface.

3. Intrabronchial electrocardiography would seem to be a useful technic to determine whether the cardiac action currents are distributed to the body surface by preferential pathways or throughout the body as though it were an approximate field.

REFERENCES


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Circulation. 1950;2:419-421
doi: 10.1161/01.CIR.2.3.419
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
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