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EXPERIMENTAL BUNDLE BRANCH BLOCK IN THE MONKEY [1]

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Among the evidence upon which the electrocardiographic localization of bundle branch block depends is the experiment performed by Lewis on a Rhesus monkey. This result he considered to be crucial, and it formed in large part the basis from which he derived his views regarding the levocardiogram and dextrocardiogram (1). Since his findings are in direct conflict with so much other convincing evidence it was decided to repeat this work. It is the purpose of the present communication to present the electrocardiographic changes consequent to transection of the main branches of the Bundle of His in a series of Rhesus monkeys.

METHOD

Twelve adult Rhesus monkeys were used, the anesthesia being ether by inhalation. German silver wire electrodes were inserted under the skin of the extremities. The chest was opened in the anterior axillary line on the left side following the institution of artificial respiration, and a vertical slit was made in the pericardium in order to expose the heart. Control electrocardiograms, using the three standard leads, were taken before and after the chest cavity was entered.

The branches of the Bundle of His were cut with a Knapp knife needle, the method used being a slight modification of that employed in a previous investigation (2). If electrocardiograms taken after the initial attempt remained normal, the knife was reinserted and the operation repeated. Following the production of the desired lesion, as manifested by electrocardiographic alterations, tracings were recorded at intervals to note the permanency of the change.

After one or the other branch was cut, premature contractions were produced by single induction shocks applied to the outer walls of the heart. At the completion of each experiment the heart was examined and the position and extent of the cut observed. In most specimens the main branches could be seen macroscopically directly beneath the endocardium, and without difficulty the location of the section could be ascertained. For further confirmation histologic studies were made on two of the hearts.

RESULTS

In two successful experiments the left branch was cut and in a similar number the right. In several other instances repeated attempts were necessary before successful transection of a division was accomplished. None of these was incorporated in the results because the electrocardiographic alterations were complicated by extensive injury to the myocardium or to the bundle itself. Also, none was used in which there was damage to the septum of the opposite ventricle. However, no data generally inconsistent with recorded results were obtained.

Of the two experiments in which the left branch was definitely cut, the subsequent electrocardiograms in both instances showed an initial main deflection in Lead I which was upwardly directed and widened with a terminal wave downwardly directed. Lead III presented a widened negative QRS complex with the terminal wave opposite in sign. The curves were therefore of the discordant type (in the sense employed by Lewis) (Figure 1).

In the two instances of successful transection of the right branch, the QRS complex was widened and downwardly directed in Lead I with a terminal upward wave. In Lead III the main deflection was upright in one instance and the reverse in the other, the terminal wave always being opposite to the main deflection. On transection of the right branch, therefore, the curves were either concordant or discordant, with the main deflection in Lead I being consistently negative (Figures 2 and 3).

[1] Read by title at the Proceedings of the American Society for Clinical Investigation, Atlantic City, May 6, 1935.

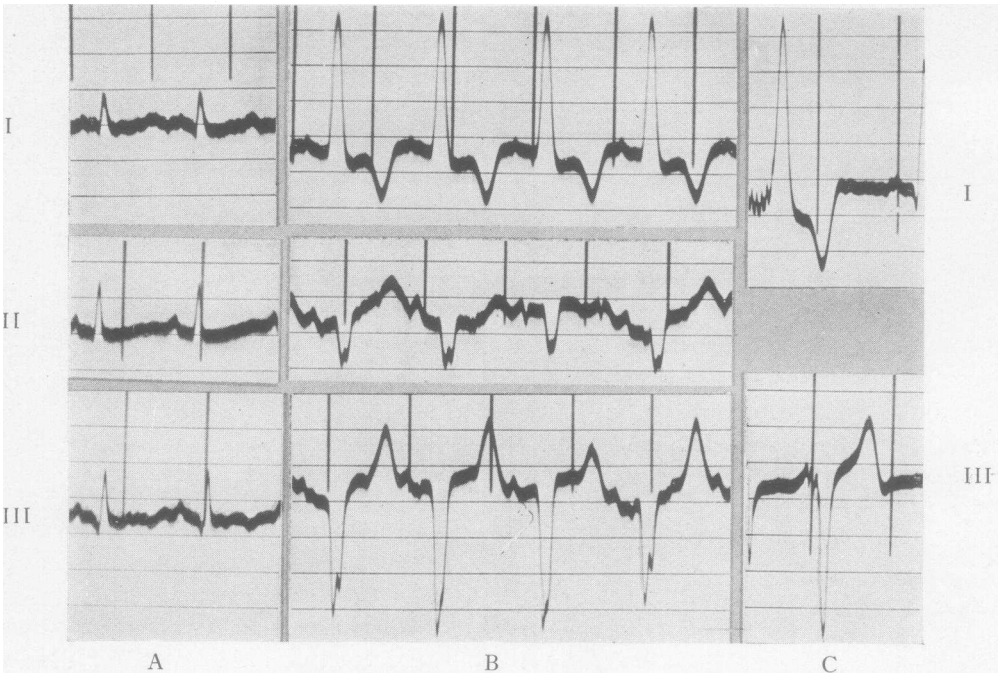

FIG. 1. TRANSECTION OF LEFT BRANCH OF BUNDLE OF HIS.

A, normal standard three leads. *B*, following transection, discordant type of curves produced. *C*, Leads I and III, showing extrasystolic waves produced by stimulation of outer wall of right ventricle. 1 cm. equals 1 millivolt. Time, 0.2 second.

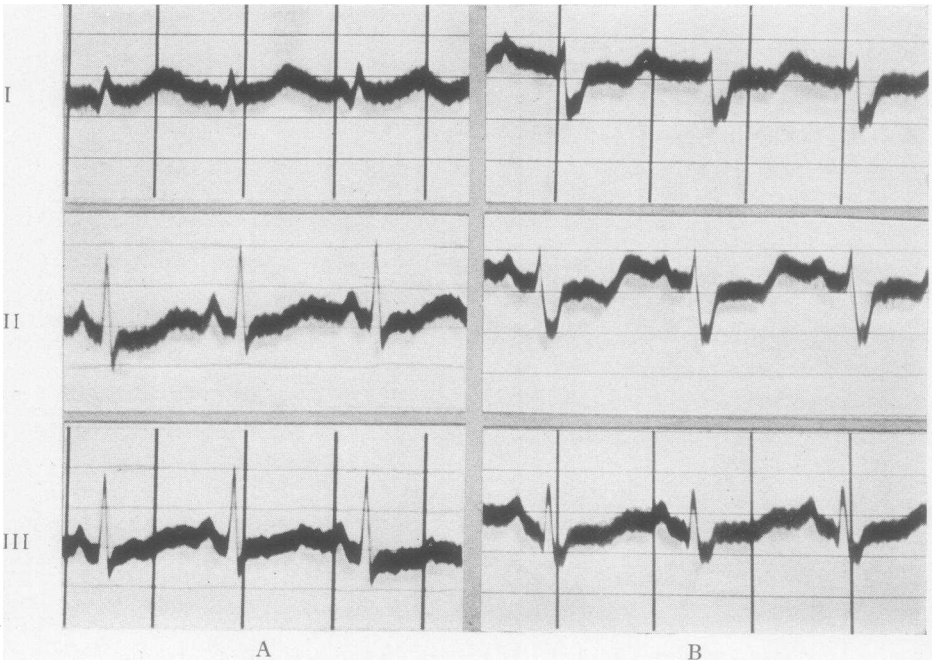

FIG. 2. TRANSECTION OF RIGHT BRANCH OF BUNDLE OF HIS.

A, normal standard three leads. *B*, following transection, discordant type of curves produced.

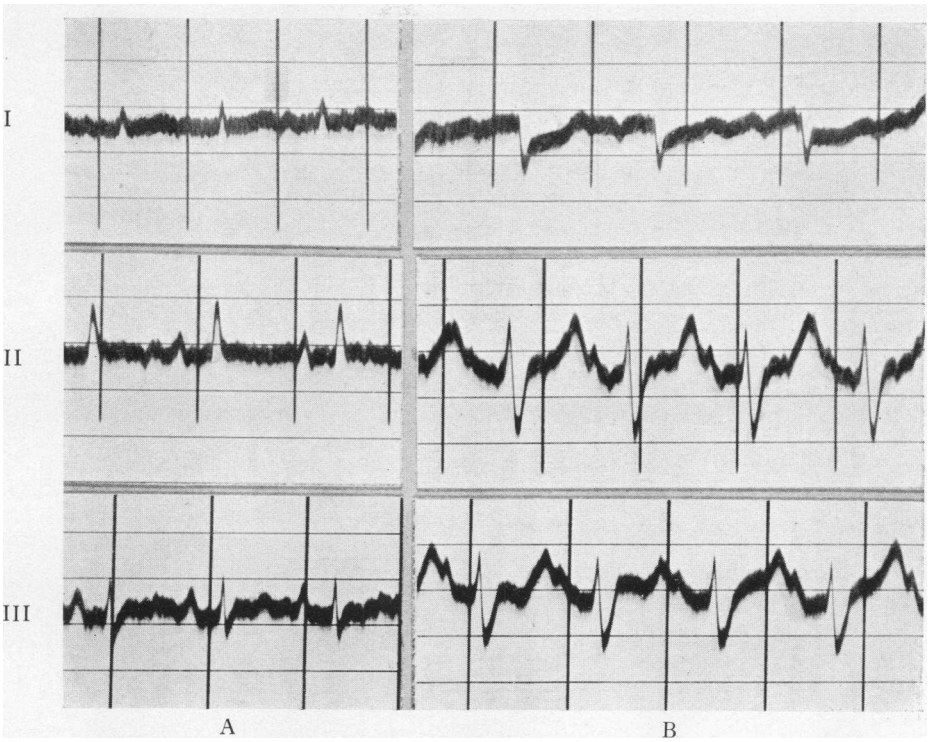

FIG. 3. TRANSECTION OF RIGHT BRANCH OF BUNDLE OF HIS.
A, normal standard three leads. *B*, following transection, concordant type of curves produced.

In the instances in which extrasystoles were obtained from one or the other ventricle, the results coincided with the above data. On stimulating the anterior wall of the right ventricle midway between apex and base, the initial main deflection in Lead I was upwardly directed (Figure 1), while a similar procedure applied to the left ventricle produced exactly opposite results. In other words, activation of the right ventricle before the left, either because of transection of the left main branch or direct stimulation of the right ventricle itself, affected Lead I so as to cause the main deflection to be positive. A corresponding relationship was found to be present also in the case of transection of the right branch and stimulation of the left ventricle.

COMMENT

The uncertainty concerning the electrocardiographic distinction between right and left bundle branch block still exists, although the new terminology has come to be widely accepted. On the other hand, some authors have either adhered to the older viewpoint or else have stated that present data will not permit a definite decision.

In the effort to settle the difficulty a great deal of discussion and some very substantial evidence have been presented, all of which has been adequately reviewed in recent publications. In support of the classical terminology no experiment has been more widely cited than that of Lewis in which he compressed the right branch of the Bundle of His in a single Rhesus monkey. His original report does not include the actual records, but a chart representing the temporal and quantitative relationships of the initial ventricular deflections is illustrated (3). This chart shows an upwardly directed chief initial deflection in Lead I and a downwardly directed corresponding deflection in Lead III. Lewis called this the levocardiogram, and from this data calculated a curve representative of the effects of left branch block in which the initial deflection is downward in

Lead I and upward in Lead III; this he called the dextrocardiogram.

So far as we know this experiment has been repeated but twice. Wilson and Hermann cut the right branch in one monkey but unfortunately obtained concordant curves (4). Subsequent transection of the left branch resulted in complete heart block. Since the completion of our experiments Kountz and his associates reported the effects of transection of the right branch in two monkeys and of the left in one (5). In the former, discordant curves were obtained which were down in Lead I and up in Lead III. In the latter, a curve was produced that was up in Lead I and down in Lead III. Their results and ours therefore are the direct opposite of those reported by Lewis.

SUMMARY

Following division of the left main branch of the His Bundle in the Rhesus monkey, the chief initial deflection of the electrocardiogram is upright in Lead I and downward in Lead III.

Division of the right branch results in initial deflections downwardly directed in Lead I and either upward or downward in Lead III.

Stimulation of the ventricle contralateral to the lesion produced complexes, the deflections of which corresponded in direction to those of the bundle branch block.

The recorded data are further evidence in support of the new terminology of bundle branch block localization.

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